THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1925

VOL. L.

WITH FIFTY PLATES
and 242 Text-figures.

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CORRIGENDA.

Page 234, line 19, for *bitumulosus*, read *bitumulatus*
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NATIONAL MUSEUM MELBOURNE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

WEDNESDAY, 25TH MARCH, 1925.

The Fiftieth Annual General Meeting, together with the Ordinary Monthly Meeting, was held at Macleay House, 16 College Street, Sydney, on Wednesday evening, 25th March, 1925.

ANNUAL GENERAL MEETING.

Mr. R. H. Cambage, F.L.S., President, in the Chair.

The Minutes of the preceding Annual General Meeting (26th March, 1924) were read and confirmed.

PRESIDENTIAL ADDRESS.

This meeting closes officially the Society's fiftieth year of scientific work, and it would not appear to be out of place to call your attention to what the Society has accomplished during its first fifty years.

For many years after the foundation of the Society, meetings were held right through the year, but about 1893 the summer vacation was instituted and so the Annual Meeting was moved from January to March. The actual fiftieth anniversary of the first meeting was on 13th January last, and to mark the occasion a reception was held, to which representatives of kindred bodies were invited, and which proved a very successful function.

A writer in an American journal has said: "Fifty years is a variable quantity. It is the major part of a man's life, an era for a nation, a passing moment in geology. For a magazine it is a ripe and venerable age."

For a scientific society, too, fifty years is a ripe and venerable age, and when we look back over the fifty years' work of this Society we must realise that its continued success has been made possible by two things, (1) the unbounded generosity of Sir William Macleay and (2) the enthusiasm of the comparatively small band of members. Without either the Society could not have carried on as it has.

Of the 99 original members* of the Society none has continued his membership to the present day, and, as far as we know, only three—John Brazier, W. H. Hargraves and Professor A. Liversidge—are still living, and we send them most cordial greetings and good wishes for their future comfort and happiness. We have recently lost Professor Haswell, who had been a member since 1879, and we rejoice that we have still with us two members elected in 1881, Dr. T. Storie Dixson and Mr. J. J. Fletcher.

There can be no occasion on which it would be necessary for your President to ask your indulgence while he recounted this Society's debt to Sir William Macleay, but to-night's meeting would be incomplete without some brief account. The full story can never be told, for during the earlier years of the Society's existence no one but Sir William himself knew to what extent he shouldered the financial liabilities of the Society. We have only to look at the size of the volumes of Proceedings for those early years and make a rough estimate of their cost to know that the Society's whole income would not nearly have sufficed to pay for the printing. If we add the cost of renting offices, the salary of an assistant secretary and other incidental expenses we will realise that, as honorary secretary for a number of years, Sir William must have allowed the honorary treasurer to pay only such accounts as the Society's limited income would permit.

After the Garden Palace fire, in which the Society lost all its belongings, Sir William rented a house, 54 Phillip Street, paying £300 a year rent, for the Society's use. Then he offered, as recounted in the Macleay Memorial Volume, to defray the cost of a building if the Council could obtain a suitable site at a convenient locality in the city. As the Council could not see its way through the financial difficulties involved in such an undertaking, he then offered to provide the land at Elizabeth Bay and erect the building, an offer which was gratefully accepted. He did this in 1885 and, as you all know, the Society occupied the new home on 2nd January, 1886. From this same date Sir William also made perhaps the best investment that has been made in the Society's interests, by the engagement, as Secretary and Director, of Mr. J. J. Fletcher to undertake the general management, under the direction of the Council, of the Society's affairs and the editing of the Proceedings.

In 1890 Sir William decided that the time had come to give the Society some measure of security and independence as regards its finances, and he therefore transferred to it by way of endowment a mortgage of £14,000 bearing interest at the rate of 5%; at the same time he transferred the Linnean Hall, with the land on which it stood, having a frontage of 179 feet to Bay Street (now Ithaca Road) by a depth of 120 feet, to the Society for the balance of his lease, a period of about 84 years.

By his will Sir William bequeathed a further sum of £6,000 to the Society and, subject to a life interest by Lady Macleay, the sum of £35,000 for the establishment of four research fellowships—the Linnean Macleay Fellowships. He also bequeathed to the University, under certain conditions, the sum of £12,000 for the employment of a research bacteriologist, but the University, in 1895, notified its intention to relinquish the bequest and the money reverted to the Linnean Society. The Macleay Bacteriologist was appointed towards the end of 1898; the first Linnean Macleay Fellow as from 1st April, 1905. The capital of the Bacteriology Fund has been increased to £14,000 by capitalisation of accumulated surplus

* Nominally there were 107 original members, but 8 of this number did not accept membership.—Ed.

income. At the time when the Fellowship Fund became available, rates of interest were less than at the time Sir William made the bequest and the income was not sufficient to support four fellowships. The Council, therefore, after seeking the judgment of the Chief Judge in Equity, capitalised the surplus income each year until the yield was sufficient to support the four fellowships in the terms of the will. The will then directed that "The interest on the endowment over and above four hundred pounds a year for each Fellow shall be taken for the general use of the said Society at the discretion of the Council thereof," but the Council for some years continued to capitalise the surplus in order that, in the event of interests falling in the future, the yield would still be sufficient to maintain the four fellowships. It seems that Sir William intended the surplus to recoup the general fund for the extra expenses involved in the printing of Fellows' papers, and in the administration of the trust. By foregoing this surplus for a number of years the Council has assured the future of the fund for, even if the interest rate falls as low as 3½%, the lowest rate the Society has ever received, the income will only be a few pounds a year short of the sum required to maintain four Fellows.

Since the establishment of these two trusts the Society has expended, in carrying them out, nearly £14,000 salaries and expenses from the Bacteriology Fund, and over £22,000 salaries and subsidies from the Fellowship Fund, a total of just over £36,000 in all.

If we add to this an expenditure from the General Fund since 1895 (the balance-sheets were not published before 1896) of over £17,000 in salaries, etc., and nearly £15,000 on the printing of the Proceedings, we begin to realise what Sir William Macleay's generosity has meant to the Society.

During the period that the Fellowship Trust has been in force, Fellows have totalled 55½ yearly tenures, which have been distributed among the various subjects as follows: Biochemistry 18, Botany 5, Geology 8, Physiology 3½, and Zoology 21; the number of individual Fellows being 14, and the average length of tenure four years.

A notable occurrence during the past year has been the Society's change from Elizabeth Bay to Macleay House, College Street. When the Council purchased the latter property in 1923 there was no prospect of the Society having to take possession before February, 1925, possibly August, 1927, on account of the existing lease. Without warning, however, early in 1924 the lessee approached the Council intimating that she was unable to carry on her part of the lease and asking to be released. The circumstances were such that the Council had no option but to agree and to take possession at once. The necessary alterations and renovations to make the building suitable for occupation by the Society were put in hand immediately and the Society's offices were moved on 19th May, 1924, the first Council meeting in the new building being held on 23rd July, 1924, and the first ordinary monthly meeting on 30th July, 1924.

For many years the meetings of Council had been held in the city in order to save the time of members. Through the courtesy of the Principal Librarian of the Public Library, the Board Room was made available for these meetings for a number of years prior to 1915, but, in consequence of congestion in the Public Library building, the arrangement had to be discontinued and the Council had to look elsewhere for a meeting-place.

Application was made to the Council of the Royal Society for the use of a room for meetings. It was asked that this application should be treated strictly

as a business proposition, but the Council of the Royal Society very generously offered the use of a room for which it refused to accept any payment. This offer was gratefully accepted and from April, 1915, to June, 1924, the ordinary monthly meetings of the Council were held in the Royal Society's Rooms.

I take this opportunity of placing on record our appreciation of the generous and friendly action of the Royal Society in allowing us for more than nine years to hold our meetings in their rooms.

During 1924 the Council considered that in view of the heavy cost of maintaining the property at Elizabeth Bay it was desirable to sell portion of it, and arrangements were put in hand for the disposal of three lots. These were submitted to auction by Messrs. Richardson and Wrench during February and realised quite satisfactory prices.

The concluding part of Volume xlix of the Society's Proceedings has been issued. The complete volume (544 plus lxxxi pages, 60 plates and 203 text-figures) contains thirty-seven papers from twenty-nine authors. The papers cover a wide range of subjects in Zoology, Botany, Geology and Chemistry. The Society's research staff have contributed eight papers to the volume.

Exchange-relations with scientific societies and institutions have been well maintained, the receipts for the past session numbering 1457, as compared with 1450 for the previous one. The name of the Ohara Institute for Agricultural Research, Japan, has been added to the exchange list during the year.

The efforts made by the Zoological Society of London to secure additional financial support for the *Zoological Record* were successful with regard to the volume for 1922, which has now been issued, and the printing of the volume for 1923 is in progress. The contributions towards the cost of the 1922 volume provided a surplus which has been carried over towards the cost of the 1923 volume. Your Council has again contributed in order to reduce the estimated deficit on this volume.

During the year three members of the Council, Mr. C. Hedley, Professor A. A. Lawson and Mr. A. F. Basset Hull have resigned, and one, Professor W. A. Haswell, died. Mr. Hedley, on account of his position as Scientific Director of the work of the Great Barrier Reef Committee, must spend a considerable part of his time in Queensland, and Mr. Hull proposes to be away from Sydney during a large part of the next year or so. Professor Haswell had been a member of Council since 1881, Mr. Hedley since 1897, Mr. Hull since 1915 and Professor Lawson since 1922. I take this opportunity of expressing our appreciation of the services rendered to the Society, as well as to Science, by these gentlemen. Your Council elected Mr. A. R. McCulloch, Dr. W. R. Browne and Dr. H. S. H. Wardlaw to fill the vacancies caused by the resignations, and will, at its next meeting, fill that caused by the death of Professor Haswell.

Professor Sir Edgeworth David and Mr. J. H. Maiden have joined the ranks of those who have retired from official duties. Both have served the Society as members of Council for long periods—Professor David since 1891, and Mr. Maiden from 1887-1922. We wish them both many years in which to enjoy the leisure which they have so well earned.

I have much pleasure in offering the Society's heartiest congratulations to:—

Sir Edgeworth David on his election, in common with five other world famous geologists, Drs. J. J. Sederholm, F. A. A. Lacroix, A. S. Woodward, G. A. F. Mollengraaff and B. Koto, to the Honorary Degree of Correspondent by the Geological Society of America; Professor L. A. Cotton, a former Linnean

Macleay Fellow, on his appointment to the Chair of Geology in the University of Sydney; Dr. R. J. Tillyard, on his selection as a Fellow of the Royal Society of London; Dr. G. P. Darnell Smith, on his appointment as Director of the Botanic Gardens in succession to Mr. J. H. Maiden; Miss Marjorie I. Collins, on being awarded a Dominion Research Scholarship for one year, tenable at the Imperial College of Science and Technology, London; and also on being one of the first graduates to obtain the degree of Master of Science in the University of Sydney; Dr. G. A. Waterhouse, on obtaining his doctorate in Science at the University of Sydney; Dr. A. N. Burkitt, on his appointment as Associate Professor of Anatomy in the University of Sydney; Mr. G. H. Hardy, on the continuance of his appointment as Walter and Eliza Hall Fellow in Economic Biology at the University of Queensland for a further period; and Mr. E. Cheel, on his appointment as Curator of the National Herbarium at the Botanic Gardens.

The reading of papers at the ordinary meetings was again supplemented by lecturettes, illustrated with lantern slides, for which we have to express our thanks to Professor Lawson, Mr. D. G. Stead and Mr. A. Musgrave.

Since the beginning of 1924, the names of ten ordinary members have been added to the roll, four members have resigned, four names have been removed from the roll, we have lost by death two ordinary, one honorary and one corresponding member, and we have received word of the death of one ordinary member in November, 1923. This leaves the number of ordinary members at 165.

Giovanni Battista de Toni, Professor of Botany in the University of Modena, Italy, and editor of *La Nuova Notarisia*, the well-known publication devoted to the Algae, died at Modena, on 31st July, 1924. He had been an honorary member of this Society since 1897.

Francis Jeffrey Bell, a corresponding member since 1884, died in London on 1st April, 1924, as the result of an accident. He had charge of echinoderms and worms at the British Museum during a long period between his appointment in 1878 and his retirement in 1919. He published many papers on these two groups, more especially the former, and described the echinoderms of the *Alert*, *Southern Cross* and *Discovery* expeditions, the results of which are of importance to Australian workers in Science.

William Aitcheson Haswell, who died at his home, "Mimihau," Point Piper, on 24th January, 1925, was born at Gayfield House, Edinburgh, Scotland, on 5th August, 1854. He was educated at the Edinburgh Institution, proceeding to the Edinburgh University, where he won seven University medals and the Baxter and other Scholarships; he also won the prize for poetry, the subject given being the Death of Livingstone, the explorer. He obtained the degrees of Master of Arts and Bachelor of Science before he came to Australia, and that of Doctor of Science in 1887. A fellow student at the University was Lord Haldane; the two studied Mental Philosophy and Logic together, often on long walks, and their life-long friendship was formed at this time. Haswell studied geology under the late Sir Archibald Geikie and surgery under Lord Lister. He was studying Medicine, but before he qualified he gave it up in favour of Natural History. Later he studied in Germany and travelled in America as well as Europe. He came to Australia partly for health reasons in 1878 or earlier, for he was first introduced as a visitor at the meetings of this Society on 30th December, 1878. His first paper before the Society was read on 25th November, 1878, though there is no record whether he was present at the meeting or not. This paper contained

descriptions of six new species of Annelids, the material having been collected on the *Chevert* Expedition. He was again present as a visitor at the meeting on 29th January, 1879, and was elected a member of the Society on 30th April the same year. Before his election as a member he had contributed five papers to the Proceedings. In December, 1879, he was appointed Curator of the Queensland Museum at Brisbane and took charge in January, 1880. In November of the same year he left Brisbane for Sydney, having had greater inducements offered him. He was elected a member of Council of this Society at the Annual Meeting, 27th January, 1881, remaining on the Council till his death. He went as a guest of the captain of H.M.S. *Alert* on a surveying cruise to the Great Barrier Reef in 1881.

In 1882 he was appointed Demonstrator in Zoology, Comparative Anatomy and Histology at the University of Sydney, and later Lecturer in the same subjects; in 1890 he was appointed to the newly-created Chair of Biology, which he held until his retirement in 1917, his title having been changed to Professor of Zoology in 1914 on the appointment of a Professor of Botany. On his retirement the Senate of the University conferred on him the honoured title of Professor *emeritus*. As a zoologist it was natural that he should take an interest in the work of the museums. For some time in 1883 he was Acting Curator of the Australian Museum, during the absence of the late Dr. E. P. Ramsay. On 3rd February, 1891, he was elected a member of the Board of Trustees of the Australian Museum and he gave valuable service in that capacity until he resigned in December, 1923.

This Society has reason to appreciate the way in which Professor Haswell contributed to its success, not only by assisting in the management of the Society for forty-three years, but by the continuous series of papers published in the Proceedings. In 1881, by arrangement with Sir William Macleay, he delivered a course of twenty lectures on Zoology under the auspices of the Society at the Garden Palace. His first paper was read in November, 1878, his last in November, 1924, only two months before his death. During the forty-six years he contributed no less than seventy-four papers, in addition to one in collaboration with J. P. Hill. These papers include for their subject matter almost every group in the Animal Kingdom and even one botanical paper, "Notes on Tmesipteris and Psilotum." He had an especial interest in the flat-worms, particularly the parasitic Temnocephaloidea, on which his first published paper appeared in 1888 and which were also the subject of the last paper he published (1924). In addition to his papers in our Proceedings, he contributed important papers to the Quarterly Journal of Microscopical Science.

On the occasion of the visit to Australia of the British Association for the Advancement of Science in 1914, he contributed to the Federal and the New South Wales State handbooks, editing the zoological sections of the latter. During the last few years, in addition to his own research work, he has edited the reports of the Australasian Antarctic Expedition, which have been printed by the Government Printer at Sydney.

Professor Haswell's zoological writings covered a very wide range of subjects. Before joining the staff of the University of Sydney in 1882, he was associated with the Australian Museum, and produced in that year his "Catalogue of the Australian Stalk- and Sessile-eyed Crustacea." The Crustacea and the Polychæte annelids constituted his chief systematic interest; and he returned to the latter group after his retirement from the Challis Chair, publishing two papers on

Syllids in 1920. One of his most notable discoveries was the demonstration of the occurrence of striped muscle in the pharynx of certain members of this family.

But he was not bound to any group, and his papers deal with almost every Phylum from the Protozoa (parasitic Euglenoids and colonial Radiolaria) to the Mammalia (brain of Gray's Whale). The paired fins of *Ceratodus*, the myology of pigeons, the embryology of the emu attracted his attention amongst the vertebrates, but there is no doubt that he was primarily an invertebrate zoologist, and that, of the invertebrates, the Platyhelminths held most interest for him. He wrote a considerable number of papers on the Turbellaria, Trematoda, and Cestoda. Possibly arising out of his early interest in Crustacea, he made a special study of the Temnocephaloidea, parasitic upon the Australian fresh-water crayfishes. He monographed the group in the Macleay Memorial Volume (1893); studied its embryology, after overcoming very great technical difficulties (*Quart. Journ. Microscop. Sci.*, 1909); and was, at the time of his death, engaged upon a revision, as well as on a detailed study of the eyes. He discovered and described two of the three known species of Histriobdellids, for which he proposed a genus *Stratiodrilus*, and here again he included in his research a study of the embryology.

Apart from research work, the "Text-book of Zoology," first published in 1898 in collaboration with Professor T. Jeffery Parker, has become the standard text-book in the English language, and it is used extensively and highly appreciated in America as well as in the British Empire. Owing to Professor Parker's death shortly after the publication of the original edition, the second (1910) and third (1921) editions were entirely prepared by Haswell, as was the abridged "Manual of Zoology" first published in 1899, and reprinted in 1908. The "Text-book" is a monument of scholarship, and is apt to disconcert the unwary student who, deceived by the ease of its English, fails to realise the compression of its matter throughout. Whether this great work will achieve a fourth edition in its present form is a moot point, for Professor Haswell was essentially a morphologist, and, although he was thoroughly familiar with the modern trends of zoological thought, he still believed in morphology as a basis. The text-book of the new zoology has yet to be devised and written, and it will differ very considerably from Parker and Haswell. But the latter work will always be sought as a repository of morphological fact, selected with a truly remarkable sanity and balance, and set forth with a wonderful clarity in scholarly language.

Professor Haswell invariably collected the material for his own researches in the first instance, although he might invite distant colleagues to gather material for comparison. He did all his own technical preparation, never seeking any help from his staff, and made his own drawings. Up to the time of his retirement from the university, his working day, after the morning lecture, or lectures, was spent immured in his private laboratory. His industry continued to the end, and he was working at the eyes of *Temnocephala* up to the time of his fatal seizure.

Professor Haswell was president of this Society for the years 1891-92 and 1892-93; he was an intimate friend of Sir William Macleay in the later years of Sir William's life, and it is more than likely that these two often discussed Sir William's idea of the endowment of the Linnean Macleay Fellowships. In his Presidential Address, Professor Haswell put forward the suggestion that a Macleay Memorial Volume should be published, a scheme that was immediately agreed to and in due course carried out.

He was elected a Fellow of the Royal Society of London in 1897, and in 1915 the Royal Society of New South Wales awarded him the Clarke Medal.

Always shy and reserved, Professor Haswell did not often appear in public affairs, but to those who were privileged to know him well and to see behind the barrier of a naturally retiring disposition, he showed himself to be a man of wide knowledge, willing to give sound advice and possessed of that strong human sympathy which makes for true and lasting friendships. One of the greatest tributes to the influence of his personality and the soundness of the zoological training he gave to his students is the fact that in four of the six Australian Universities the Chair of Zoology (or Biology) is held by one of his students.

Henry George Smith, who died on 19th September, 1924, aged 72, was born at Littlebourne, Kent, and educated at the local Grammar School. He came to Australia in 1883, and obtained an appointment at the Technological Museum under Mr. J. H. Maiden. The Technological Museum was at that time housed in the Domain, the whole of the exhibits having been destroyed in the disastrous Garden Palace fire in 1882. In 1891 Mr. Smith was appointed Laboratory Assistant at the Museum and his first scientific paper, "On the occurrence of Barite (Barytes) in the Hawkesbury Sandstone, near Sydney," was published in our Proceedings. This was the only paper he contributed to our publication, his later papers being of a chemical nature and more suited to other journals. In 1899 he was appointed Assistant Curator, a position which he held till his death. His first few papers dealt with subjects connected with inorganic chemistry, and it was not till 1895 that his first paper on organic chemistry appeared. From that time until his death his chief interest was in organic chemistry and more particularly the chemistry of certain groups of the Australian flora. A great deal of his work on the Australian flora was done in collaboration with his colleague Mr. R. T. Baker, who dealt with the botanical side, whilst Mr. Smith did the chemistry. Working in this way these two men produced a series of memoirs which will stand for all time in Australian science as a monument to their scientific ability and enthusiasm. This series included such works of world-wide fame as "A research on the Eucalypts and their Essential Oils," and "A research on the Pines of Australia."

Mr. Smith had been a member of this Society since 1899; he was President of the Royal Society of New South Wales in 1913, and was awarded the David Syme Research Prize by the University of Melbourne in 1922.

After his retirement in 1920, he continued his work in organic chemistry, attending regularly at the University laboratory, where he worked in collaboration with Professor John Read. Steps are being taken by a Committee representing the scientific societies and institutions with which Mr. Smith was connected, to commemorate, in some fitting manner, his services to Australian Science.

Robert Murdoch, who died in New Zealand in November, 1923, had been a member of this Society since 1904. He was one of those men who lead a busy commercial life and yet find the time to have a scientific hobby. His perseverance and determination were such that his study of malacology was continued throughout a great number of years. Lately the problems concerned in a study of the relation of the recent mollusca of New Zealand to that of the Tertiary era especially attracted him. He grew to man's estate without having any special scientific education, and it was only then that he began his special studies in mollusca under the guidance of that well-known authority, Charles Hedley. He was an ardent collector and gathered an important collection of New Zealand

mollusca. The personal, as well as scientific, loss was great when all his specimens were destroyed by fire while he was absent on a visit to England. Somewhat disheartened he ceased scientific work for some years, but lately published several papers on the Upper Tertiary mollusca of New Zealand. Much of his earlier work was published in the journal of the Malacological Society, and his first paper in the Transactions of the New Zealand Institute appeared in 1901. For several years after that he was occupied with the anatomy of various species of *Paraphanta*. Altogether he published fifteen papers, all the later ones dealing with Upper Tertiary mollusca of New Zealand. His work was careful, thorough and important. For many years he was President of the Wanganui Museum and of the Philosophical Society. Quiet and genial "Bob" Murdoch was a universal favourite. He had no enemies but a host of friends, some of whom are deeply indebted to him for kindly, unselfish advice and interest.

I cannot let the opportunity pass of referring to the loss suffered by Science in the death of Professor John Irvine Hunter, which took place after a short illness in London on 10th December, 1924, at the age of 27. Professor Hunter, who was elected to the Chair of Anatomy in the University of Sydney in his twenty-third year, had in four short years attained the position of a leader in his chosen profession, and his sudden removal as a result of an attack of typhoid fever is nothing short of a calamity.

At the annual meeting of the Australian National Research Council held in Adelaide in August last the future of the publication *Australian Science Abstracts* was discussed. Several proposals were put forward, but it was finally decided to continue publication as at present.

Among the matters to which the Australian National Research Council has been giving attention for some time is that of the founding of a Chair of Anthropology in Australia.

At the meeting of the Pan-Pacific Science Congress held in Australia in 1923, under the auspices of the Australian National Research Council, a resolution was passed urging the teaching of Anthropology in the Universities of Australia. Reference was made to the great and peculiar interest of the Australian aboriginals as representing one of the lowest types of culture available for study, of the rapid and inevitable diminution in their numbers, and the necessity, without delay, to organise the study of those tribes which remain.

It was also pointed out that the preservation, progress and welfare of the native population of Oceania, which is a charge under the terms of the Mandates granted to the Commonwealth of Australia, can best be carried out by a policy based on the investigation of native conditions, customs, laws, religion, and the like, which is a study not merely of academic interest and importance, but points the way to a sympathetic method of dealing with and governing such peoples.

In December, 1923, Sir David Orme Masson, of Melbourne University (President), and other members of the Australian National Research Council, waited on the Federal Government and asked that a Chair of Anthropology be established at Sydney. The movement to found a Chair of Anthropology in Australia was subsequently supported by the Australasian Association for the Advancement of Science, and the Universities of Australia, also by a personal request to the Prime Minister by Professor Grafton Elliot Smith, one of the leading Anthropologists of the world. The Commonwealth Government has now expressed its readiness to contribute up to £1000 per annum towards the cost of establishing the proposed

Chair of Anthropology, and suggests that the Governments of the various States —as interested parties in the question—should find the balance of the money necessary to carry the proposal in question into effect.

All the States of the Commonwealth have been approached by the Australian National Research Council to contribute on a *per capita* basis, and favourable replies have been received from New South Wales, Victoria and Tasmania, while communications are awaited from the remaining States.

Your Council, in August last, considered a proposal from the Australasian Medical Publishing Co., Ltd., with regard to printing. This Company has extended its arrangements and installed a complete equipment for carrying out high-class scientific printing, and the Council decided to have the Proceedings for 1925 printed by that Company.

I take the opportunity of expressing our appreciation of the friendly relations which have at all times existed between the Society and the Sydney and Melbourne Publishing Company, our printers since 1919, and of tendering our thanks to Mr. J. R. Wallace, manager of that Company, for the attention he has always given to the Society's wishes.

The year's work of the Society's research staff may be summarised thus:—

Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, has been investigating the influence of certain mineral and other colloids upon the fermentative powers of the high temperature organism, originally isolated from fermenting tan-bark. The bacterium fermented so many substances that charcoal was tested and, strange to relate, it seemed to be capable of being converted to carbon dioxide. Further investigations, however, showed that it was not the charcoal but a difficultly fermentable constituent of the medium (citrate) that had been attacked and that its fermentation had been assisted by the presence of the charcoal. A number of mineral and other colloids were tested, and as a rule these hastened the production of carbon dioxide from the slowly fermenting sugar, lactose. Most colloids are electro-negative, but the kind of charge upon the particles does not seem to matter, for while the electro-positive ferric hydroxide behaved like the electro-negative colloids and accelerated the fermentation, the electro-positive aluminium hydroxide did the reverse and hindered the fermentation.

Judging by the behaviour of agar, solid colloids are more effective than fluid, and gelatine, a colloid fluid at 60°, does not function. It is itself fermentable and it did not hasten its own destruction.

Work is in progress upon the influence of these colloids in other fermentations both by living organisms and by isolated enzymes.

It became necessary to note changes from time to time in the actual acidity during these fermentations without abstracting any appreciable quantity of the fermenting fluids. A method was developed whereby the hydrogen-ion concentration was determined in a minute droplet weighing only eight milligrammes. It should prove useful to bacteriologists and others.

Dr. J. M. Petrie, Linnean Macleay Fellow of the Society in Biochemistry, has devoted his attention chiefly to the pigments and allied substances in a number of plants. Red anthocyanin pigments were searched for in a considerable number of plants, including *Erythrina*, *Telopea* and red Eucalyptus leaves. The substances separated during the investigation of these plants, however, did not show the normal properties of anthocyanins. *Stenocarpus* and *Telopea* were found to contain a number of substances, closely allied to the pigments, and the chemical

nature of these substances has been investigated. *Erythrina* was found to contain also an alkaloid, the nature of which is being investigated. He has also carried out some further work on the chemistry of the rubber derivative present in the leaves of Eucalyptus. One paper has been contributed to the Proceedings during the year, *viz.*:—Studies in plant pigments. Part ii. The red pigment induced by insect injury in *Eucalyptus stricta*.

We are pleased to offer Dr. Petrie our congratulations on his appointment to a research fellowship at the University of Sydney, which he takes up on the conclusion, at the end of this month, of his term as a Linnean Macleay Fellow. We would like to express our appreciation of his work in investigating biochemical problems connected with the Australian flora.

Miss Marjorie I. Collins, Linnean Macleay Fellow of the Society in Botany, carried out an investigation of the life-history of a species of *Riella* found in Western New South Wales, and in addition was engaged in the preparation of the final parts of her studies on the vegetation of arid and semi-arid New South Wales. These deal with the origin and distribution of the eremian element in the Australian flora and with the effect of grazing and over-grazing upon plant communities in arid Australia. In August, Miss Collins was awarded a Dominion Research scholarship, tenable at the Imperial College of Science and Technology, London, and she resigned her Fellowship at the end of October to take up this scholarship. Whilst absent from Sydney Miss Collins will have the opportunity of discussing the results of her work in Western New South Wales with authorities on distribution in England, and also hopes to see the effects of the grazing policy in America. She is, therefore, withholding publication of her final papers until her return in the belief that they will be of greater value after she has had this additional experience. We have to offer our congratulations to Miss Collins on the award of this Scholarship, which was one of two available for Australian students.

Mr. P. D. F. Murray, Linnean Macleay Fellow of the Society in Zoology, took up his Fellowship at the beginning of May, having been granted leave of absence by the Council in order that he might obtain his Science Degree at Oxford. During the year he has carried out four series of experiments involving grafting on to, and interfering in other ways with, the chorio-allantoic membrane of the embryonic chick. These experiments, with one exception, appear to have been quite successful. Mr. Murray has also begun a series of experiments on the mechanism of differentiation as grafts of the limb-buds of the chick. This work is progressing satisfactorily and is expected to provide data on the independent differentiation of parts of the limbs and limb girdles; whether or not the limb bud is predifferentiated as a mosaic structure, and if so, whether in one or two dimensions; the relations of physical stresses and strains to the differentiation of joints, form of bones, muscles, etc.; the relation of the nervous system to the differentiation of the limb; and the power of regeneration and form regulation in limb fragments.

He has also commenced some simple experiments on the regeneration of sponges, and, in conjunction with Dr. Mackerras, has been studying the technique of tissue culture experiments. He proposes to continue all these branches of work during the coming year.

Miss May M. Williams, Linnean Macleay Fellow of the Society in Botany, commenced her investigations of the siphonaceous algae by a survey of the literature of the group, at the same time obtaining extensive collections of *Codium*, *Bryopsis* and *Caulerpa* and making preparations to follow out the development and life-histories of these types. The life-history of *Codium tomentosum* has been

investigated and important and interesting results have been obtained. Miss Williams has succeeded in showing, in this species, that a definite reduction division occurs in the gametangium, and hence the gamete nuclei are not merely vegetative nuclei which have taken on a reproductive function. In this species, the gametes are similar in structure, both are active, the only difference being in the size. These gametes are but little removed from the asexual zoospore from which they are supposed to be derived. This is the first time that reduction division has been described in connection with such a primitive form of sexual reproduction in a plant. The results of this investigation are embodied in a paper shortly to be submitted to the Society. Miss Williams proposes to continue this work during the coming year.

Dr. Walkom has carried out an examination of a large collection of Tasmanian Mesozoic plants belonging to the Geological Survey of Tasmania and the Tasmanian Museum. The first results of this examination were embodied in a paper read before the Royal Society of Tasmania in December last.

Six applications for Linnean Macleay Fellowships, 1925-26, were received in response to the Council's invitation of 24th September, 1924. I have pleasure in reminding you that the Council has reappointed Miss May M. Williams and Mr. P. D. F. Murray to Fellowships in Botany and Zoology respectively for one year from 1st March, 1925, and has appointed Dr. I. M. Mackerras and Mr. G. D. Osborne to Fellowships in Zoology and Geology respectively for one year from 1st March, 1925. On behalf of the Society I wish them a successful year's research.

Dr. Ian Murray Mackerras graduated in Science and Medicine at the University of Sydney in 1924, obtaining First-class Honours and University Medal in Zoology; he was awarded the John Coutts Scholarship in Zoology and a Government Science Research Scholarship. His researches have covered a wide range; a paper on the Haematozoa of Australian Marine Teleostei is nearing completion, and another in preparation deals with the larvae of a number of species of Australian Culicidae. He has made some observations on the Opalinidae with the object of applying the host-parasite method to the problems of the phylogeny of Australian frogs, and has also given some attention to tissue culture, having read a paper entitled "Tissue culture as a method of Cancer Research" before the New South Wales Branch of the British Medical Association. Dr. Mackerras proposes to continue these researches during the coming year, and also to commence a revision of the Diptera contained in the collections of the Macleay Museum.

Mr. G. D. Osborne graduated in Science at the University of Sydney in 1921 with First-class Honours and University Medal in Geology. He was awarded the Deas-Thomson Mineralogy Scholarship and a Government Science Research Scholarship. In 1922 he was appointed Demonstrator in Geology at the University of Sydney, which position he held for three years. Mr. Osborne commenced research work in Geology whilst an undergraduate, when he made a geological examination of the volcanic neck at the Basin, Nepean River, the results of which were published in the Journal of the Royal Society of New South Wales. Since graduation he has devoted his attention largely to the Carboniferous rocks in the Clarencetown-Paterson District, and has completed a number of papers on the geology and petrography of this district, some of which have already appeared in our Proceedings. Another piece of work on the late Palaeozoic folding in the Hunter River District has attracted very favourable notice from geologists abroad. For the tenure of his Fellowship Mr. Osborne proposes to carry out an examina-

tion of the Carboniferous rocks in the Singleton District and to the north-north-west therefrom, paying special attention to the structural and stratigraphical geology.

Fifty Years' Work of the Society.

Geology.

In the Proceedings of a Society whose aim is the cultivation and study of Natural History it is perhaps natural that geology should be overshadowed by zoology and botany. This has been so in the history of our Society, but, although geological papers have never assumed a large proportion of the papers submitted, there are, nevertheless, a number of important contributions to the science in the Proceedings. Of a total of about 2200 papers published, only one-tenth are geological, written by about 45 individual authors; the most prolific years were 1886 and 1887, when there were nine and eleven geological papers respectively, the most barren 1875, 1876, 1898 and 1899, during which no geological papers were read. The great bulk of the papers deal with palaeontological and stratigraphical subjects, the remainder (about 7%) being mineralogical and petrological.

During the first nine years the chief contributor of geological papers was the Rev. J. E. Tenison-Woods, who contributed altogether sixteen papers; of the first twenty geological papers in the Proceedings, he was responsible for fourteen. His papers dealt mostly with Mesozoic and Tertiary fossils, some of them being amongst the earliest accounts of fossil plants of New South Wales and Queensland. Especially notable is his account of the fossil flora of the coal deposits of Australia (Vol. viii), which was the first general summary of the fossil plants of Eastern Australia.

It is interesting to note that the first stratigraphical paper dealt with the geology of Yass Plains (Vol. iii, by Charles Jenkins), a region in which geologists are still very interested and from which abundant fossil remains have formed the subject of numerous papers read before the Society.

During the years 1881-1884 there were early papers dealing with subjects which have since aroused very considerable general interest, *viz.*: the occurrence of artesian wells (by C. S. Wilkinson), the geology of the western coalfield (by W. J. Stephens), the geology of the Clarence River basin (by W. J. Stephens), and on the formation of Barrier Reefs (by H. B. Guppy).

In Volume x (1885) there appeared the first of a series of papers regarding the Tertiary glacial period in Australia—a subject over which there was much discussion for many years. Papers dealing with this appeared at irregular intervals until 1908, the contributors to the controversy including R. von Lendenfeld, F. W. Hutton, J. Stirling, J. M. Curran, T. W. E. David, R. Helms and E. F. Pittman.

In Volume xi (1886) Mr. John Mitchell contributed his first paper, "Notes on the geology of Bowning." This is the earliest paper by a geologist who is still a member, and we are pleased to be able to say that Mr. Mitchell is still an active member, having contributed four papers to the last volume of the Proceedings issued. Mr. Mitchell has contributed more papers than any other geologist, his tally being twenty-nine, eight of them in collaboration with fellow-workers. His work has been chiefly concerned with the middle Palaeozoic faunas of New South Wales, more especially the trilobite and brachiopod faunas. The series of papers on the former by Mr. Mitchell and the late Robert Etheridge, Junior, is worthy of especial note.

Robert Etheridge, Junior, contributed the first of his twenty-one palaeontological papers in 1888, the last in 1917. In addition to his work on Silurian trilobites in collaboration with Mr. Mitchell, his papers cover a wide range, including both vertebrates and invertebrates, as well as plants.

In addition to three authors already mentioned (Rev. J. E. Tenison-Woods, John Mitchell and Robert Etheridge, Jr.) the only other author whose number of geological papers exceeds fifteen is Dr. R. J. Tillyard, who has contributed seventeen papers descriptive of Palaeozoic and Mesozoic fossil insects.

On the whole, palaeontological papers have outnumbered other geological papers in the proportion of about 4 : 3. The number of papers contributed by any single author does not approach the large numbers by individual botanists and zoologists (*e.g.*, J. H. Maiden 95, E. P. Ramsay, 140), the leading geological authors in this respect being John Mitchell 29, and R. Etheridge, Jr., 21.

The Linnean Macleay Fellows have, in recent years, contributed largely to the total of geological papers, for, of the eighty-eight published since 1905, fifty-four have been contributed by Linnean Macleay Fellows, either before, during, or after the tenure of their Fellowship.

Most of the geological papers in the Proceedings are self-contained, dealing with a single subject, but some are arranged in series dealing with subjects rather too wide for a single paper. Some of these series form notable additions to our knowledge of various branches of Australian Geology, and among them may be noted those dealing with the Silurian Trilobites of New South Wales (appearing 1891-1917), the alkaline rocks of Eastern Australia (1906-1909), the great serpentine belt of New South Wales (1913-1920) and the Palaeozoic and Mesozoic fossil insects of New South Wales (1917-1924).

In addition to a great many papers dealing with the general geology of districts in Australia there are several notable contributions to the geology of areas outside Australia, *e.g.*, Fiji, New Hebrides, Samoa, Perak, and the Volcano of Taal (Philippine Is.). The general geological papers deal in very many cases with districts in which there is little of economic value, and which therefore would not be examined in detail by officers of the Geological Survey.

Botany.

The progress of botanical work published by the Society during the first half-century of its existence is very satisfactory, although at the end of the first year Sir William Macleay, in the Annual Address on 31st January, 1876, stated that "Zoology seems to turn the scale upon Botany and Geology." No botanical paper was published in Volume i, but much has been done since, the first paper on this subject being one by F. M. Bailey on "A General Account of the Flora of Tropical Queensland" (Vol. ii, 276). This paper contains popular descriptions of and references to some of the more conspicuous and useful members of the Queensland flora. Mr. Bailey contributed six out of the first eight botanical papers accepted by the Society.

It is of interest to note that of the first fifty botanical papers, by ten authors, published by the Society in Volumes ii to viii, no less than thirty-four were written by clergymen. Of these, eighteeen were contributed by the Rev. Dr. W. Woolls, ten by the Rev. J. E. Tenison-Woods, four by the Rev. B. Scortechini, one by the Rev. P. A. O'Shanesy, and one by the Rev. C. Kalchbrenner.

The fact that among the ardent Botanists of nearly fifty years ago there was such a large proportion of clergymen goes to show that in those days there were less educated people with botanical tastes outside the ranks of the clergy than now.

During the earlier years of the Society's existence the botanical papers were to some extent of a somewhat general character and dealt with areas in New South Wales and Queensland. Later, new species were described from time to time, some by Baron Ferdinand von Mueller, who was a regular contributor to the Society's Proceedings for many years, and published twenty-eight papers.

Beginning in 1880, the Rev. Dr. W. Woolls wrote various papers on "The Plants of New South Wales," and later devoted much time to writing on the difficult genus *Eucalyptus*, a subject which he, from long years of close observation, was particularly competent to discuss. He was one of the most valuable supporters of the botanical section which this Society has had, and contributed thirty-six papers.

The Rev. J. E. Tenison-Woods wrote much in regard to the Queensland vegetation, and also introduced the subject of paleobotany.

The writings of the Rev. B. Scortechini were descriptive of the flora of Queensland.

In 1882 Mr. E. Haviland commenced a series of papers entitled "Occasional Notes on Plants indigenous in the immediate neighbourhood of Sydney," and in addition to papers on fertilization, he also wrote a series on "Flowering Seasons of Australian Plants," which he commenced in 1886. Altogether he contributed nineteen papers.

The Rev. Dr. Woolls, the Rev. B. Scortechini and Mr. E. Haviland were the chief botanical contributors to this Society during the first decade of its existence, with Mr. F. M. Bailey not far behind. All these authors have now passed away, having left the Society and the botanical world richer for their efforts.

In 1885, Mr. A. G. Hamilton wrote a paper "On the fertilization of *Goodenia hederacea*." This was followed by a "List of the Orchideæ of the Mudgee District," and by several other papers on the fertilization of various plants, also on the domatia in certain Australian plants. In 1899, his paper "On the Flora of Mount Wilson" was published, and this was one of the first papers contributed to the Society which had reference to the ecological side of plant life. Altogether he has published eighteen papers in the Society's Proceedings. It is now forty years since Mr. Hamilton gave his first paper to the Society, and we are delighted that he is still with us and a member of our Council.

In the year 1887, Mr. J. H. Maiden contributed a paper entitled "Notes on some Indigenous Sago and Tobacco from New Guinea"; this was followed by another entitled "Some reputed Medicinal Plants of New South Wales," and shortly afterwards he commenced a series of papers on the gum and other exudations yielded by various plants. Later, in conjunction with Mr. R. T. Baker, he began a series of papers called "Botanical Notes from the Technological Museum, Sydney," and in 1897, after he had been appointed Director of the Botanic Gardens, he started another series called "Notes from the Botanic Gardens, Sydney," in conjunction with the late Mr. E. Betche. With both these authors new species of plants were described. Subsequently, in collaboration with the late Mr. Henry Deane, Mr. Maiden wrote much concerning the genus *Eucalyptus*, describing many new species, though very many more were subsequently described by Mr. Maiden

alone. Altogether, this most energetic scientific worker has, either singly or in conjunction with others, contributed ninety-five botanical papers to this Society, and we look forward to further work from his fertile brain and facile pen.

In 1891, Mr. R. T. Baker commenced a series of papers entitled "Some New South Wales Plants Illustrated," in addition to his work already referred to as joint author with Mr. Maiden. Later he wrote various papers under the title of "Contributions to a Knowledge of the Flora of Australia." He described many new species of plants, including a considerable number of the genus *Eucalyptus*, and, in collaboration with the late Mr. H. G. Smith, much was done in investigating the essential oils contained in the leaves, and the results obtained were used by him as factors to assist in differentiating species. Mr. Baker has enriched the Society's publications by forty-two botanical papers, and we hope for further contributions from this fruitful source.

In 1895, the late Mr. Henry Deane, with Mr. Maiden as joint author, commenced a series of papers on the genus *Eucalyptus*, and described many new species. Important papers on the Tertiary flora by Mr. Deane were published in the Society's Proceedings in 1900.

During my association with the Society I have never seen greater botanical activity than when Mr. Maiden, Mr. Baker and Mr. Deane were busily engaged in their good work of unravelling the intricacies of the genus *Eucalyptus*. Metaphorically speaking, they all appeared with their coats off, and the botanical world, as well as this Society, is richer for the result of their excellent labours.

During the second twenty-five years of the Society's existence, botanical activities have been continued at the hands of many writers.

In addition to descriptions of new species, with special investigations of various genera, and a history of development, the subjects dealt with have included the following: Fungi, Lichens, Mosses and Hepatics, Plant Ecology, Fresh-water and Marine Algae, Ferns, Seedlings, Anatomical Structure, Leaf-Morphology, Aquatic Phanerogams, Plant Biochemistry, Shoot-bearing swellings at the base of Eucalypts, Paleobotany, Studies in Symbiosis, and Plant Pigments.

The botanical exhibits from time to time have supplemented the extensive series of other exhibits in adding to the interest of the Meetings in a very important way.

It is freely admitted in the scientific world that the progress of the Society has been of a most satisfactory nature, and that the general standard of its work has been of a high order. Towards this result the botanical section has made meritorious contributions.

Zoology.

During the first year of this Society's existence more activity was shown in regard to the subject of Zoology than any other. This was to some extent a natural circumstance, seeing that our benefactor, Sir William Macleay, was essentially a Zoologist.

To cover the whole range of the zoological work placed before the Society would be a task far too great to attempt for the purposes of this address. The following short summary gives a list of those members who commenced their contributions during the first twenty-five years of the Society's existence and have contributed not less than ten zoological papers. Many others have also done good work in Zoology. During the second half of the Society's life zoological papers have continued to come forward in a very satisfactory manner.

The first paper communicated to the Society was a description of fourteen new species of shells from Australia and the Solomon Islands read by John Brazier on the 25th January, 1875. During the years 1875 to 1898 this author contributed about 80 papers, chiefly on Mollusca.

E. P. Ramsay contributed no less than 140 papers on birds, fishes and various other forms of life in the years 1875 to 1889. This author read more papers before the Society than any other member has done, and twenty were published in the first volume, covering a period of two years.

Sir William Macleay contributed 80 papers to the Society during the years 1875 to 1888, chiefly on fishes and insects.

Dr. James C. Cox contributed 20 papers during the years 1875 to 1899 on the subjects of Conchology and Anthropology.

George Masters contributed 15 papers during the years 1875 to 1896, which chiefly formed a catalogue of described Coleoptera of Australia.

The Rev. J. E. Tenison-Woods contributed about 40 papers on Zoology during the years 1876 to 1888, chiefly on shells. These were in addition to his papers on Geology and Botany.

Baron N. de Miklouho-Maclay contributed 19 papers on various zoological and anthropological subjects during the years 1878 to 1885.

E. Meyrick contributed 32 papers chiefly on Lepidoptera and Microlepidoptera during the years 1878 to 1911.

F. W. Hutton, of New Zealand, contributed 15 papers, chiefly on Mollusca, during the years 1878 to 1904.

Professor W. A. Haswell contributed 73 zoological papers during the years 1878 to 1924; these dealt with almost every Phylum from Protozoa to Mammalia.

J. J. Fletcher has contributed about 35 papers altogether, including 27 zoological papers, during the years 1881 to the present time; these dealt with urogenital organs of kangaroos, earthworms and frogs.

C. W. De Vis contributed 41 papers during the years 1882 to 1895 on fishes and birds.

R. von Lendenfeld contributed 47 papers, chiefly on sponges, during the years 1884 and 1885.

J. D. Ogilby contributed 40 papers, chiefly on fishes, during the years 1885 to 1899.

A. S. Olliff contributed 27 papers on Coleoptera and Lepidoptera during the years 1885 to 1892.

A. J. North contributed 32 papers on birds during the years 1886 to 1908.

F. A. A. Skuse contributed 16 papers on Diptera during the years 1887 to 1892.

T. G. Sloane has contributed 48 papers, chiefly on Coleoptera, during the years 1888 to 1923.

W. W. Froggatt has contributed 46 papers on Entomology during the years 1888 to 1924.

The Rev. T. Blackburn contributed 30 papers, chiefly on Coleoptera, during the years 1888 to 1904.

Charles Hedley has contributed 50 zoological papers, chiefly on Mollusca, during the years 1890 to 1924.

W. J. Rainbow contributed 16 papers on spiders during the years 1892 to 1902.

Dr. J. P. Hill contributed 12 papers during 1893 to 1900 on marsupial urogenital organs and allied subjects.

A. M. Lea has contributed 36 papers on Coleoptera during the years 1893 to 1924.

Robert Broom contributed 18 papers on Mammals during the years 1895 to 1911.

Dr. G. A. Waterhouse has contributed 11 papers on butterflies during the years 1897 to 1924.

In addition to the three subjects of Geology, Botany and Zoology, numerous papers have been contributed in other branches, including Anthropology, Physiology and Biochemistry.

From our hearts we feel grateful to those worthy pioneers who, in the formation of this Society, laid such a solid foundation for work in natural science in Australia, and we are filled with admiration at the ultimate success of those great students of science who carried on so magnificently under the conditions of half a century ago, while through it all we see the benevolent hand of that great and generous man, Sir William Macleay.

Need for a Botanical and Soil Survey of New South Wales.

The great necessity for obtaining an accurate record of the distribution of the native plants of this State, and a knowledge of the factors, geological and otherwise, which regulate such distribution, is one which appeals to all who have given this matter any consideration. Spasmodic efforts by various individuals, usually in their private capacities, have been made from time to time, as opportunity has offered, for the purpose of gradually carrying out a botanical survey, much valuable information being contained in the National Herbarium, Sydney, and the Proceedings of this Society have been used considerably to record and thereby make available the results of such efforts. The Forestry Department has also collected many useful facts concerning the distribution of timber trees.

In regard to the soil survey of the State, important contributions have been made by officers of the Department of Agriculture, and action was taken about a dozen years ago by that Department which resulted in a valuable publication being issued on "The Soils of New South Wales" (1914), the work having been performed by H. I. Jensen, D.Sc. The carrying on of this work has since been much retarded, presumably from the want of funds. In making the soil survey in question, consideration was also given to the matter of correlating the relationship between the soils and the native vegetation.

One very important reason why a joint botanical and soil survey should be made as soon as possible is because the unique native vegetation, much of it endemic, is such an excellent index to the nature of the soil, and, therefore, advantage should be taken of the assistance so afforded before the further destruction of plant-life has taken place.

That there is a relationship between soil and plants was noticed in Australia by very early writers.

In the first geological paper prepared in Australia, and read by Alexander Berry in March, 1822, before the Philosophical Society of Australasia, the first scientific society in Australia, the following passage occurs: "Much has been written about the geography of plants. Equal attention ought to be given to the soils which they delight to inhabit. This is not the place for such discussions. Still, as being intimately connected with my present subject, and so important,

that there can be no successful cultivation of exportable commodities in this colony without attention to it, I cannot conclude without adverting to it." *

An early reference to this subject by one of Australia's greatest explorers, Charles Sturt, is of interest. He wrote: "Whilst prosecuting my researches in the interior of the colony, I could not but be struck with the apparent connection between its geology and vegetation; so strong, indeed, was this connection, that I had little difficulty, after a short experience, in judging of the rock that formed the basis of the country over which I was travelling, from the kind of tree or herbage that flourished in the soil above it."†

Factors which Regulate Plant Distribution.

Speaking broadly, it may be said that the two great factors which regulate the distribution of our native flora are climate and geological formation, and, of these, the dominating influence is climatic, though, over small areas having similar climatic conditions, the modification of the vegetation is due to variation in the geological formations.‡

The climate of any locality is determined by the latitude, elevation, rainfall and aspect, the latter to a large extent regulating the distribution of atmospheric moisture.

A brief outline of the climatic feature as it affects New South Wales may be given as follows:§ This State lies approximately between 28½° and 37° south latitude. Approximately parallel with, and at an average distance of about 80 miles from the east coast is a range of mountains, or for a great part plateaux, reaching about 2200 to 7000 feet above sea level in the south, and about 4000 feet in the north. This Main Divide, which at its closest point south-east of Cooma, is only about thirty-five miles from the ocean in a straight line, is the important factor in regulating the question of aspect in this State, and divides the eastern or moist area from the western or dry division, while in itself it provides the conditions necessary for a cold-loving flora, excepting in the vicinity of Cassilis, between Mudgee and Muswellbrook, where the gap at one point is less than 2000 feet, and permits of an intermingling of eastern and western floras, but causes a break in the continuity of the true mountain vegetation.

The annual rainfall in the coastal region approximates 41 inches to the south of Sydney and about 51 inches to the north of it, though these figures are exceeded at various points. The mountain area has an average annual rainfall of about 34 inches, the western slopes about 26-27 inches, and the interior about 13-14 inches, with less than 10 inches at Broken Hill.

The question of aspect, as dominated by the Main Divide, should receive the fullest attention in connection with any botanical survey which may be made, and also, for the purpose of its general utility, in connection with any soil survey, for although soils may be chemically the same on both aspects, their resultant productiveness will vary according to the amount of moisture present either in the atmosphere or in the soil itself.

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* A. Berry: On the Geology of Part of the Coast of New South Wales. Field's *New South Wales*, p. 253.

† Charles Sturt: Two Expeditions into the Interior of Southern Australia, During the Years 1828, 1829, 1830 and 1831. Vol. i, 1834, xxx.

‡ R. H. Cambage: Climatic and Geological Influence on the Flora of New South Wales. *Report Aust. Assoc. Adv. Science*, xi, 1907, 473.

§ R. H. Cambage: The Mountains of Eastern Australia and their Effect on the Native Vegetation. *Journ. Roy. Soc. N. S. Wales*, xlviii, 1914, 267.

Perhaps one of the most striking examples of the effect of aspect and the dominant wind towards the summit of the Main Divide is to be found in the Kosciusko area, where it is evident the prevailing current comes from the westward. An examination of dead branches on Eucalyptus trees discloses the fact that, although the bark may still be adhering to the eastern side of the dead twigs and branches, the western side has had the bark removed from it by the dominating westerly wind, and has been worn perfectly smooth. A similar effect may be seen on the snow-poles erected on the roadside. The feature can be made use of for the purpose of orientation, when it is recognised that the polished surface always points to the westward.

It is in the flora of the eastern or coastal area that the Malayan or jungle element exists, coming in strongly from the north, and diminishing as the more southern latitudes are reached, being assisted in its southerly journey by the presence of certain geological formations, but in most cases it is under special sheltered conditions only that this type of vegetation is found west of the Main Divide, and then only in what may be called a subdued form, and where it is sheltered from the drying westerly influence. This applies, among others, to examples of *Alsophila australis* (Tree-ferns) as far west of the Main Divide as the Nandewar Mountains and the Warrumbungles. On the other hand *Ficus rubiginosa*, *Alphitonia excelsa* and *Brachychiton populneus* (Kurrajong) may occur both in sheltered portions of the coastal area and in exposed portions in the west, but these are more adaptable species.

As the Main Divide is followed northwards through Queensland, where its elevation becomes less, it is found that its influence in differentiating the eastern and western aspects is much lessened, partly because of its reduced altitude and partly from the effect of warmer latitudes. While in various places this allows some of the western vegetation to pass well over on to the eastern watershed, and reach such spots as around Rockhampton, the Main Divide is still sufficient to prevent the eastern or moisture-loving flora from crossing to the western side. This is well shown near Kuranda, about twenty miles by train westerly from, and about 1100 feet above Cairns. The jungle flora extends up to Kuranda, but a few miles beyond this the conditions suddenly change, and the western vegetation appears and continues right to Normanton.

Investigation has shown that in certain places west of the Main Divide, which are shut off from western influence, though exposed to the eastern or coastal, such as on the eastern side of a north-south range, the vegetation has more of an eastern than a western facies. An example of this may be seen on the eastern side of Mount Coree, near Canberra, where *Olearia argophylla* (Musk-tree), *Dicksonia antarctica* (Tree-fern), and *Bedfordia salicina* occur in the sheltered portions, thus showing that the locality is not exposed to the western or dry atmosphere. Numerous examples of a similar nature could be quoted.

Conversely to this, there are instances on the eastern side of the Main Divide where areas are sheltered from the moist coastal influence, and in these cases members of the western vegetation make their appearance. Such an area may be found in the deep valley of the Wollondilly at Upper Burragorang and towards the Wombeyan Caves, where at certain points such western plants as *Eucalyptus albens* (White-box) and *E. melliodora* (Yellow-box) occur.

Quite close to the same locality, near the Wombeyan Caves road, west of the Wollondilly, where there are nooks quite sheltered from western conditions, such

moisture-loving plants as *Laportea gigas* (Stinging-tree) and *Dendrobium speciosum* (Rock-Lily) are to be found.

The classical spot for studying the effect of the western conditions east of the Main Divide is on the lower Goulburn and part of the upper Hunter Rivers, around Denman, Wybong, Scone and Gundy. Owing to the lowness of the gap near Ulan (the Cassilis Geocol of Professor Griffith Taylor*), which is only from about 1700-2000 feet above sea-level, the effect of the mountain barrier is removed. To the eastward of the Hunter River rises the Mount Royal Range, including the Barrington Tops, extending in a north and south direction, and largely shutting off portions of the Hunter and Goulburn Valleys from the moist coastal conditions, while the rainfall is reduced to about 24 inches annually. Here the stage is set for a contest between eastern and western conditions, and one is interested in seeing which side gets the greater number of plants through the gap. An investigation shows that the western conditions succeed in getting a greater number of typical western plants through to the eastern watershed than are passed through in return from east to west. It is true that there are a few coastal plants on the western side of the Divide, and not far from the gap, as recorded by Mr. A. G. Hamilton,† such as *Pittosporum undulatum* and *Dendrobium speciosum*, but the conditions within the Geocol are not such as to have assisted such plants in reaching the western side of the Divide, and they have succeeded in crossing by avoiding the dry westerly influence, and have arrived at their destination by other agencies.

When dealing with questions of aspect, consideration should be given to the effect of sunlight and warmth. The slopes on either side of a deep east and west valley, or the sides of a high hill, have opposite aspects, north and south, often with a consequent variation in the vegetation. In such cases, those groups of Eucalypts known as Box-trees and Stringybarks, if present at all, are likely to predominate on the north and south sides respectively of the hill, or on the south and north sides respectively of the east and west valley. This is in direct response to the influence of the sun, and examples of this are well shown in deep gorges towards the sources of rivers on the north coast of this State, particularly the upper portions of the Macleay.

Eucalyptus Bosistoana, a Box-tree, occurs sparsely on Mount Towrang, near Goulburn, where it was noticed some years ago on reddish soil on the northern side of the mountain. On reference being made to its presence, a local resident remarked that "it grows only on the sunny side where the soil is red." In such a case as this we have a local example of the joint influence of climate or aspect and geological formation, possibly the presence of iron in some form, regulating plant distribution.

It may be mentioned that many bushmen acquire valuable information relating to climatic and geological influence on the native vegetation, but owing to want of some literary ability or lack of opportunity their observations go unrecorded.

In connection with the effect of sunlight, the question of canopy has to be considered; and, in a botanical survey, information should be obtained showing whether certain plants flourish best under the shade of other vegetation or in the open. Without this information the difficulty of successfully replanting in the years to come will be increased.

* A correlation of Contour, Climate and Coal. THESE PROCEEDINGS, xxxi, 1906, 517.

† A List of the Indigenous Plants of the Mudgee District. THESE PROCEEDINGS, xii, 1887, 259.

Another important factor in regard to aspect, especially in view of the position of the Main Divide in this State, is the moisture in the atmosphere, or humidity, as well as the rainfall, and the Indo-Malayan element of the coastal flora of this State, and cognate genera, demand both. Some moisture-loving plants will not thrive in a district, even with a good rainfall. They require not only water for their roots, but moisture for their leaves, and in order to secure the latter condition they will thrive only in sheltered positions. Evidence of this requirement may be seen at various places along the coastal area, the extreme need for shelter being made manifest towards the summit of the Divide, where certain trees seek out the sheltered gullies for protection against the dry atmosphere which comes from the west. Among these moisture-loving trees are *Cedrela toona* (Red Cedar), *Doryphora sassafras*, and *Laportea gigas* (Stinging-tree).

In some cases the moisture-loving Malayan element will join forces with the geological formation, and by establishing itself in good soil, having also sufficient rainfall, will drive out all the representatives of such a hardy genus as *Eucalyptus*, the species of which, with those of other genera, help to form a shelter for the brush or jungle flora. One of the most aggressive Eucalypts in only fairly successfully trying to enter the jungle is *E. microcorys* (Tallowwood), and others are *E. saligna* (Blue Gum) and *E. quadrangulata* (Brush Box), while one of the least successful is *E. corymbosa* (Bloodwood).

The importance of atmospheric humidity and evaporation is so great that it is desirable that a record of these factors should be obtained in connection with a detailed botanical survey.

Effect of Latitude.—It is of interest to note how certain plants which belong to the western districts come up the western slopes and approach the mountain zone, but are held in check by the cold. *Eucalyptus albens* (White Box) may be taken as typical. South of the Murrumbidgee, or in south latitude about 35½°, this tree is seldom found at an elevation exceeding about 1400 feet. In going north it is found that around Orange, or in latitude about 33¾°, it is able to ascend to about 2000 feet, while around Emmaville, west of Deepwater, in latitude about 29½°, owing to warmer conditions, it flourishes in some cases at elevations up to 3000 feet above sea-level.

Influence of Geological Formations.

Although climate is the dominating factor in regulating the distribution of plant life over a large area or country, the changes in geological formation within that region are responsible for a great number of most interesting variations of a somewhat local nature, according to the extent of a particular formation. These edaphic variations are the result of conditions occurring in the soil.

As there is still a great quantity of native vegetation available, a soil survey of this State, or any portion of it, should embrace, if possible, an ecological investigation of plant life, for the changes in geological formations produce a corresponding variation in the native flora, and this change is so pronounced as to be noticeable to an observer even when hurriedly passing through the forest. In making a detailed survey of this nature it is desirable that botanical, geological, chemical, and bacteriological knowledge should be applied to the work.

Briefly the botanical operations would include the identification and listing of the plants and associations, together with a mapping in of the areas where they

occur, and recording the elevations, and all climatic, including meteorological conditions, also to note whether the soils in which the plants grow are rich or poor in humus.

The geological knowledge would afford the means of supplying information in regard to the name and class of the rock furnishing the soil upon which the plants are growing, and the probable underground water supplies of the areas.

The chemist would furnish information relating to the quantity and quality of the various constituents and water capacity of the rock or soil, particularly in relation to the occurrence of plant foods.

The bacteriologist would report on the bacteria present in the soil and their effect on the question of aeration of the soil, and the promotion of soil fertility.

Broadly speaking, the native flora of this State is distributed under two extreme classes of geological formation, the siliceous and the basic, upon which occur totally distinct types of vegetation, while in places there is a sort of common ground with neither extremely siliceous nor excessively basic rocks and soils, and which produces a sort of intermediate vegetation.

Numerous occurrences may be seen of two distinct floras growing side by side, each coming up to a common line but not intermingling, the one growing on a highly siliceous formation of either granite or sandstone with an abundance of free silica, and the other on a basic rock producing a rich soil.

It is true that where a thin basic lava flow has spread over a siliceous rock, some plants, which favour siliceous soils, may survive on the overlying basic soil until their roots have penetrated the siliceous formation below, and afterwards may appear to be thriving on the basic rock, while in reality their roots have reached the formation the plants desire. Some trees of *Eucalyptus Bancrofti* were once found on the Nandewar Mountains growing under these conditions, and as it was known that trees of this species usually require a soil containing not less than 70% of silica, an investigation was made which resulted in showing that the basalt in which they appeared to be growing was thin, and was resting on a siliceous volcanic agglomerate into which the roots had no doubt penetrated.

It is remarkable that the amount of silica in the rock from which the soil is produced should apparently have so much to do with regulating the distribution of plants, and yet such appears to be the case, as it is often possible from an inspection of the vegetation *in situ*, to estimate the quantity of silica present in the local rock to within three or four per cent., and sometimes less, and this in rocks containing up to 75% of silica. Whether it is the physical conditions produced by the free silica from the weathering of the rock, or the presence of chemical constituents, from which the quantity of silica derives a regulating influence, seems difficult to decide, but probably both factors operate. An abundance of free silica in the soil would give it increased capillary properties. In any case silica is a most useful index for reference in the study of the distribution of a native flora.

"In studying the analyses of a series of rocks, it is noticed that, broadly speaking, the ferro-magnesian constituents increase as the silica decreases, and the basic rock therefore produces the more chemically-rich soil; while on the other hand those granites with a high percentage of silica are usually richer in potash than are the basic rocks. The proportion of soda, however, has no regular gradation according to either increasing or decreasing quantities of silica, but of the two types of rock, the soda usually occurs more plentifully in the basic than in the highly siliceous. Apart from the question of the chemical constituents

there is that of the mechanical condition of a soil, and it seems undoubted that in certain cases the physical characters are of greater importance to the plant than the chemical constituents. It is, of course, those rocks with a high percentage of free silica which so largely affect the physical characters of the soil, and furnish it with capillary properties, so that when a plant exhibits a definite preference for a highly siliceous formation it may be that it neither wishes to avoid some constituent which occurs in a large proportion in the more basic rocks, nor that it prefers something which is only formed in the highly siliceous, but rather that the porous state of the soil allows the moisture to reach the plant, and so enables it to avail itself of the particular food it requires." . . . . "In dealing with the acidity and alkalinity of soils produced from the same type of rock in various localities, the question of the local rainfall and topography must be considered, for it will be at once apparent that a decomposing alkaline rock in a dry climate will furnish a soil containing a higher percentage of alkali than will be produced by a similar rock in a wet climate, for the reason that in the wet area the soluble alkali will be more readily leached out, and some of it washed away. The difference in the alkalinity of the resultant soils will be accentuated if the moist area is in mountainous country and the dry locality on the level plains, for in the former case the alkali is readily washed away after leaching out, and in the latter both operations are retarded."*

Among the geological formations around Sydney having a typical flora, is the highly siliceous Hawkesbury Sandstone of the Triassic period, which has a vegetation distinct from that of the more basic Wianamatta Shales overlying portion of this sandstone. The floristic character of the Hawkesbury Sandstone follows that rock on to the Blue Mountains, which gradually rise to an elevation of about 3600 feet, but for the last 1000 feet of the ascent the dominating influence of climate over geological formation is plainly manifest, for many of the coastal or lower country species gradually drop out, and mountain or cold-loving plants take their places, although the geological formation remains practically the same.†

Mr. E. C. Andrews, who has closely studied the physiography of Australia, has written as follows: "In Australia the land appears to have been worn down to a low-lying surface towards the close of the Cretaceous, and much of the area so worn down was of a barren, sandy, or hungry clay nature. During the Tertiary the eastern side of the continent had been elevated by stages to its variable height, and the waste from the plateaux so formed was carried, in part, by the inland drainage to form the rich soils of the great plains of the interior."‡

The waste carried to the interior was no doubt enriched by a considerable proportion of the Tertiary basalts, as evidenced by the composition of the black soil plains.

It is generally considered that it was owing to the presence of these sandy areas in early Tertiary time that such a large proportion of endemic vegetation developed, much of it being of a xerophytic character. The battle between this endemic xerophytic vegetation and the Malayan jungle element is still in progress, and under present conditions of climate and rainfall, neither one is able to gain

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* R. H. Cambage: Presidential Address, *Journ. Roy. Soc. N. S. Wales*, xlii, 1913, 21, 23.

† *Report Aust. Assoc. Adv. Science*, xi, 1907, 475.

‡ The Development and Distribution of the Natural Order Leguminosae. *Journ. Roy. Soc. N. S. Wales*, xlviii, 1914, 357.

the ascendency over the other, each being dominant in its own particular geological formation and attendant conditions. On the other hand, as pointed out by Andrews (*supra*, p. 369), with a greatly increased rainfall in Australia, the Malayan element would gradually crowd out the endemic flora, while with a much reduced precipitation the jungle flora would perish and the endemic vegetation would hold sway.

In addition to requiring shelter and moisture, the jungle flora favours basic geological formations, and its extension southward along the eastern coast of New South Wales has been made possible by the presence of areas of the more basic rocks. South of Sydney the jungle flora is absent from the highly siliceous Hawkesbury Sandstone formation, except where there are a few sheltered pockets of enriched soil, partly from other formations as in the National Park, and even this does not produce typical jungle. But on the Permian shales and volcanic soils of Illawarra the brush or jungle vegetation was, and, where preserved, still is, luxuriant.

A large area south of the Shoalhaven River for a distance of nearly forty miles is again siliceous, with an absence of jungle, which latter, however, again makes its appearance at Milton, on a soil derived from a basic rock known as Milton monzonite, allied to diorite, and having a silica content of about 51 to 55% and an abundance of plant foods. Except for some small isolated patches, there is little more jungle flora for nearly eighty miles, or until Mount Dromedary district is reached, where there is a soil very similar to that at Milton, and by the time this locality is reached, many of the more typical northern species, such as *Cedrela toona* (Red Cedar), have been left behind.

As showing the importance of geological formation in regulating plant distribution, it may be stated that if these somewhat isolated basic rocks did not occur on the South Coast, there would be practically no jungle flora south of Sydney. But if there be sufficient warmth and moisture, as in the more northern latitudes, the Malayan element may thrive even on very siliceous formations. A good example of this may be seen at Bellenden Ker, near Cairns, in about south latitude 17°, where the mountain side is largely covered with jungle flora to the summit at about 5000 feet. The rock formation is chiefly granite containing as high as 72% of silica, but having a rainfall exceeding 150 inches annually.

The great similarity between the floras of a highly siliceous granite and a sandstone area has been mentioned on various occasions. Nor is the fact remarkable seeing that the composition of the soil from both sources is much the same. But this great similarity is only seen when the granite contains at least about 70 to 72% of silica. Where the granite contains less than 68% of silica, the resultant flora will not be regarded as typical of sandstone, and if in a mountain locality, exposed to westerly influence, will produce more open forest growths, whereas a siliceous granite containing, say, upwards of 72% of silica, will produce many more species and individuals, and the vegetation will be of a more scrubby nature generally, and yet the granite with less than 68% of silica will furnish a chemically-richer soil.

It is a matter of extreme satisfaction that of late years an increased number of papers on the subject of ecology has been forthcoming, not only to this Society, but also to other Australian institutions, for there are many important problems of an ecological character awaiting solution.

Plant Selection of a Geological Formation.

As showing the assistance which may be obtained in extending the known range of a plant from noting the particular formation on which it occurs, the following two examples may be quoted.

Casuarina stricta (She Oak) extends from South Australia, across portion of Southern New South Wales, through Victoria to Tasmania. It had not been recorded for the County of Cumberland in 1905, but in that year it was found at Newport, growing on the Chocolate Shales of the Narrabeen formation of the lower Triassic period, but not on the adjacent Hawkesbury Sandstone, nor on the Wianamatta Shales. It is well-known to geologists that the Narrabeen beds dip southerly from Narrabeen, and are soon out of sight, passing under Sydney at a great depth, but coming to the surface again around Otford, some thirty-five miles from Narrabeen. As the plant seemed to show such partiality for a particular formation in this instance, it was considered not unlikely that it had also sought out the outcrop of Narrabeen Shales near Otford. The locality was then visited, and *Casuarina stricta* found to be abundant on the shale but again absent from the adjoining sandstone. It has since been found that a limited area of it occurs at Cronulla on sandy soil heavily charged with iron, but not extending back from the ocean more than a couple of hundred yards.

A second instance of where the geological formation assisted in extending the known range of a species was where plants of *Acacia vomeriformis* were being examined for seeds on the mountain side at Mount Victoria. The plants in the locality were few in number, and this led to the discovery that they were confined to a small outcrop of Narrabeen Shales on a rather steep hillside. As it was known that a more extensive outcrop of this same formation occurred on the less steep opposite side of the mountain, nearly a mile away, the spot was visited, where a further growth of these plants was at once found and followed for some distance along the outcrop of the shale formation.

Floristic Character of Rocks of Various Geological Periods.

The geological periods of rock formations in New South Wales, from the oldest to the newest, may be given as follows: Pre-Cambrian, Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, and Tertiary.

As the vegetation on rocks or resultant soils of these various geological periods is so much influenced by the local topography and climate, the work of ascribing any particular class of present day growth to rocks of a definite period, or as resulting from rocks of any definite period is very difficult, and in many cases well nigh impossible, and would necessitate much lengthy and detailed investigation. The rule is that if near the junction line of rocks of separate periods the formations are similar, then the resultant vegetation will be similar irrespective of the difference in age of the periods; but if the formations are not similar, then the vegetation will differ. It is conceivable that certain granites and limestones of the Silurian period, especially in so far as supporting plant life is concerned, may be similar to those occurring in the Devonian period; or, on the other hand, the differences in granites and limestones, in some cases, of either the Silurian or Devonian age may possibly be as great as if they belonged to separate periods.

The factor which has most to do with influencing the quality of the soil derived from rocks of any particular period is the volcanic element, or some other form of basic intrusion, either contemporaneous or subsequent. Sedimentary rocks are often enriched, so far as the production of good soil is concerned, by the presence of andesites, diorites, tuffs, basalts, etc. Evidence of this among the older formations may be seen in the central western districts of this State and elsewhere.*

Pre-Cambrian and Cambrian.—These rocks, so far as definitely known, are confined in this State to near its western boundary, where the rainfall is usually less than ten inches annually. These semi-arid conditions very largely govern the distribution of the flora in such places, and it is there we see the members of the great xerophytic genus *Eucalyptus* largely driven to the vicinity of the water-courses or water-bearing areas, while another sturdy xerophytic genus, *Acacia*, will survive under drier conditions, thus showing it to be the hardier genus of the two when facing regions of extremely low rainfall. Plants of the Family Chenopodiaceae are common in this dry area, growing largely on the alluvium accumulated from the weathering of rocks of various geological periods.

Ordovician and Silurian.—The rocks of the Ordovician and Silurian periods are somewhat similar, and are largely made up of slates and limestones, though the limestone is more plentiful in the Silurian period, the slates of both often showing considerable metamorphism. They are found on both sides of the Main Divide, but occur more plentifully on the west than on the east and form the country rock of many goldfields. Both are associated more or less with igneous rocks.

Although lime is an important plant food, a characteristic of this limestone in the Western districts is that numerically it is a poor producer of both genera and species. It is, however, the formation specially selected in nature by the well-known Kurrajong (*Brachychiton populneus*), and although this tree, when not growing on limestone, is satisfied with a chemically-rich soil, it shows a decided preference for limestone, sometimes almost exclusively occupying areas of this formation.

Pure Ordovician and Silurian slates as a rule produce only a fairly good soil, but where they are associated with igneous rocks, such as diorite or basic granite, or with limestone, the resultant soil is of a much better quality. Much of the wheat land of the central western district of this State owes its good quality to this cause. The vegetation growing on these formations is largely influenced by climatic conditions.

Devonian.—Rocks of the Devonian period occur in many places in this State, and consist of quartzites, conglomerates, shales, claystones, sandstones, tuffs, and limestones. The flora of this formation varies according to whether the rock upon which it is growing is siliceous or basic, this again being dominated by climate, plants on the highlands differing from those on the lowlands.

This formation is very common in the Rydal district, and consists of a considerable proportion of conglomerate which furnishes a fairly siliceous soil. This soil, however, is apparently less siliceous than that of the local granite, as may be seen from the following. Some years ago it was noticed that *Banksia marginata* (Honeysuckle), which selects a rock containing not less than 70% of silica, was

* See the following papers on Volcanic Action in this State: T. W. Edgeworth David: *Report Aust. Assoc. Adv. Sci.*, iv, 1892, 64; and C. A. Sussmilch: *Journ. Roy. Soc. N.S.W.*, lvii, 1923, 1.

growing on the granite between Rydal and Hampton, but avoided the conglomerate, and there seems no other reason for this except that the soil from the conglomerate was of too basic a nature. The Devonian rock is overlying the granite around Rydal, so that it is only where the former has been denuded and the granite exposed that the *Banksia* is growing. It was known that on the opposite side of Rydal, towards Bathurst, there was a spot called Honeysuckle Hill, and an examination of the geological map prepared by the late Mr. C. S. Wilkinson disclosed a small area of granite at this spot surrounded by conglomerate, but it is evident the *Banksia* had found it out, hence the locality received the name of Honeysuckle Hill.

It is examples such as this which show the great value of observing plant distribution and plant ecology for the purpose of obtaining assistance in connection with geological surveying, especially reconnaissance work.

Carboniferous and Permian.—The rocks of the Carboniferous and Permian (Permo-Carboniferous) periods are somewhat similar, and consist largely of sandstones and shales, as well as conglomerates, the Permian formation containing the important coal measures of the State. They extend to both sides of the Main Divide, though the Permian are largely developed on the coastal side, and are associated with plutonic and volcanic rocks, the latter including lava flows and tuffs. Where the sandstones of the Permian period occur they furnish a fairly siliceous soil, but the vegetation is not indicative of such a siliceous soil as that of the Hawkesbury Sandstone of the Triassic. The climatic influence does much to regulate the distribution of the flora, but on a typical Permian area around Maitland *Eucalyptus maculata* (Spotted Gum) and *E. crebra* (Narrow-leaved Ironbark) are common, and denote a better soil than that selected by *E. corymbosa* (Bloodwood), which thrives on the highly siliceous Triassic sandstone. Where the Permian sandstones and shales are associated a very fair soil is produced, including examples of the Malayan element. Some decomposed Permian shales alone, if in sheltered valleys on the coastal or moist area, may produce a good brush flora. Much of the jungle flora of Illawarra is the product of the volcanic tuffs and lavas, sometimes mixed with Permian shales.

Triassic and Jurassic.—The rocks of these two periods in New South Wales are largely composed of sandstones and shales, the sandstones sometimes containing upwards of 80% of silica, and on this rock the Malayan or jungle flora can obtain no footing. Even some of the shale, much of which contains less than 70% of silica, does not appear to be suitable for the production of tropical growths in their native state, but where this soil is enriched with basalt or volcanic tuffs, of the Tertiary period, some of the tropical brush vegetation appears.

There is perhaps no soil in the State which produces a greater number of species than the highly siliceous Triassic sandstone.

Cretaceous.—The Cretaceous formation in New South Wales, which consists largely of sandstone, is confined to a considerable area in the hot north-west, and is largely covered with alluvium, as well as being within a belt of comparatively low rainfall, and the flora is composed of xerophytic types of many genera, but with nothing in it of the Malayan element.

Tertiary.—The Tertiary rocks of the State, so far as the sedimentary portion is concerned, occupy only a small area, and impart no particular character to the native flora. The Tertiary basalts, however, are a most important factor in influencing the character of the vegetation, particularly in the coastal and the mountain regions, and to some extent in the interior. There is nothing better

than this Tertiary basalt to illustrate how absolutely dependent upon geological formation is the resultant vegetation over an area, large or small, which is subject throughout to the same climatic conditions. On various parts of the coastal and mountain region of this State, having a rainfall of from about forty to fifty inches annually, there are large areas of fairly siliceous rocks and soils carrying beautiful Eucalyptus forests; but where the silica in the rock is above 70% there is an absence of the Malayan or jungle element in the flora. But on those portions which are covered with decomposed Tertiary basalt the floristic character is altogether different, even though the rainfall over the whole area is the same, and on the basaltic soil, members of the brush or jungle flora appear. Numerous examples could be quoted of the two classes of vegetation growing side by side. The effect of the basaltic soil in producing a jungle flora over a very large area in this State, to the exclusion of the endemic vegetation, was best seen on the Richmond River prior to the clearing operations which have turned many miles of this brush country into richly grassed pasture lands.

Salinity of the Soil.

Quite apart from plants such as Mangroves, which follow around the seashore and grow in salt water, there are others which favour saline conditions and may grow right on the bank of a saltwater estuary, or may flourish some miles away where perhaps only slightly saline conditions exist. Such a plant is *Casuarina glauca* (Swamp Oak), which grows into a fairly large tree. This species, in addition to growing along the shores of Port Jackson and similar localities, often follows the banks of freshwater creeks in the Wianamatta Shale, but is an indication that the water in such creeks would become slightly brackish in drought time, or when it ceased to flow. When the Swamp Oak grows back from the creek it indicates some degree of salinity in the soil.

Another tree of the same genus, *C. Cunninghamiana* (River Oak), follows the banks of freshwater streams in their higher reaches, but ceases as soon as saline conditions are encountered, and is always an indication of the presence of good fresh water. Various instances may be seen of these two species meeting at the junction of fresh and salt water, neither transgressing beyond its naturally chosen soil. The subject is worthy of careful investigation.

C. Cunninghamiana is a common tree on the banks of the western rivers of this State, as also is *Eucalyptus rostrata* (River Red Gum). These two species may grow side by side overhanging the bed of a river, say, the Murrumbidgee, for several hundred miles. Their companionship downstream, however, is terminated by the River Oak declining to go beyond a certain spot, and the position of this terminal point seems to be regulated by some condition of the soil, or possibly by the increased heat of the low lands. It is well known that the water of many of the western rivers soaks away at the lower levels, thereby lessening the flow of the stream, and it seems probable that this allows the water to become slightly brackish in places where small brine springs are known to exist during dry summers.

In any stream the larger gravels are deposited in the upper portions, while the finer sediments are carried to the lower reaches, and Mr. A. G. Hamilton has suggested to me that this variation in the texture of the soil may be the regulating factor in the distribution of this species, which seems possible.

In their journey upstream the River Oak and River Red Gum remain together until the colder conditions of the higher country are too great for the latter, when

it allows the River Oak to proceed alone, but after it ascends about another 500 feet in elevation, the Oak finds the cold too severe and it proceeds no further. Thus the lower and upper terminal points on the river of this *Casuarina* are possibly regulated by soil and climatic conditions respectively, or wholly by climate considerations.

One of the most remarkable instances of a tree occasionally showing a taste for a saline soil is that of *Eucalyptus tereticornis* (Forest Red Gum). Normally this tree grows in open forest land on good soil, not highly siliceous, which when cultivated makes sweet pasture. Occasionally, however, small patches of this species may be found on highly siliceous soil, and within a few yards, or in rare cases a few feet, of salt water. It is well known that salt water becomes filtered when passing through certain sand, and that fresh water may sometimes be obtained a few yards from salt water. The cause of the divergent taste possessed by this tree presents a very interesting problem for solution, but it seems probable that it is attracted by some particular plant food which neutralises the effect of the saline and other conditions which it usually avoids.

Texture of Soil.

In addition to chemical differences between various soils there are also diverse physical conditions, and these latter are sometimes rendered patent to an observer by the class of vegetation which a soil produces. Broadly speaking, it may be said that a siliceous rock furnishes a sandy soil which makes a fairly good road in wet weather, but a basic rock produces a soil of fine texture which often becomes boggy under wet conditions. In the western districts of New South Wales, as elsewhere, there are many trees which differentiate between these two extremes of soil, under exactly similar climatic conditions, but there are few more discriminating than *Callitris robusta* (Cypress Pine) and *Acacia pendula* (Myall), the former selecting the siliceous and the latter the basic soil, the black soil plains which make atrocious roads in wet weather, and neither ever crossing from one to the other.

Botanists are familiar with the discrimination which various plants show in selecting hilly or rocky situations on the one hand, and valleys or alluvium on the other. In the western districts, where some of the hills are worn down almost to the level of the intervening alluvium, the geologist and the physiographer may often obtain assistance in tracing disappearing contours, from the presence of a few hill-loving trees such as *Acacia doratoxylon*, or other species which avoid the true alluvium.

These plant indicators are well known to bushmen, and in 1892 a loaded vehicle was twice bogged on the road from Dubbo to Tomingley, where the predominant tree in the locality was *Eucalyptus sideroxylon* (Ironbark or Mugga), and the formation was of a sedimentary origin, possibly Silurian slate. After the vehicle had been twice extricated from its miry bed, the driver, who was from a neighbouring district, and was passing over this track for the first time, looked wistfully along the road he had to travel and remarked with quiet confidence, "I shall be alright once I get into that White Box country I can see ahead." The White Box referred to was *Eucalyptus albens*, and was growing on a soil of granite origin.

It seems probable that these two species of trees had selected the different soils, the one which became boggy in wet weather and the other which did not,

not only because of their diverse chemical constituents, but also because of their physical conditions, which were perhaps regulated to some extent by the amount of free silica the soils contained.

Treeless Soils.

The question of treeless soils is a universal one and presents many difficulties. In arid lands it is doubtless owing to the extremely low rainfall that many miles of country are without trees, but there are numerous places in this State and other parts of Australia where bare open areas occur surrounded by forests, and in districts with a good rainfall. In the Kiandra district, at about 4600 feet above sea-level, much of the country is very sparsely timbered, and in places treeless, though the annual rainfall exceeds 60 inches.

When travelling in 1913 from Winton to Longreach, in Central Queensland, on the head-waters of streams which flow into Lake Eyre, a treeless plain of sixty-five miles was crossed, and my notes show that the first tree or shrub met with was *Atalaya hemiglauca* (Whitewood).

The late Edward Palmer when writing of the country on the right bank of the Flinders River, which flows into the Gulf of Carpentaria, refers to the water from some of the springs having a strong taste of soda. He also says: "The whole extent of country travelled through consists of treeless plains, covered with good pasture grass, and occasionally some small white wood trees (*Atalaya hemiglauca*)."*

It seems possible, therefore, that this plant, which is common in the northern portion of the interior of this State, is one of the best of the shrub or tree types to face certain conditions of soil which all other trees avoid, though it often grows in company with other trees, and an investigation into the food requirements or preferential tastes of this species, together with an analysis of the soil, would be likely to illumine the question of the occurrence of some of these treeless areas, at least in the interior.

These open spaces are not uncommon, however, in the coastal and mountain regions of this State. On the Monaro Tableland there are many treeless miles of basalt soil, but where a more siliceous formation occurs there are tree growths. Even on a few of the summits of basaltic hills, stunted forms of *Eucalyptus coriacea* (Snow Gum) and *Acacia melanoxylon* (Tasmanian Blackwood) occur. It is highly probable that the soils of these basaltic summits are more siliceous than a soil produced from basalt weathering on a gentle slope or in a horizontal position, for in the first case the plant foods which are leached out are readily washed away. It may be that an excess of soda retards plant growth, and this is an ingredient which would be readily removed by water from the summit of a hill.

The same condition in regard to tree distribution may be seen at Canberra, where the summits and sides of the hills are clothed with open forest, while the intervening lower areas are open plains. The rocks at Canberra, which include quartz-porphyries and quartz-felsites, are more siliceous than the Monaro basalts, and the hills, therefore, are more thickly timbered.

It seems possible that the question of aeration of the soil on the lower levels may be a factor in modifying the growth of plants, and this, perhaps, to some extent, may be influenced by the presence or absence of certain bacteria, or possibly earthworms.

* "Early Days in North Queensland," by the late Edward Palmer, 1903, p. 70.

It seems doubtful, however, if bacteria and earthworms usually penetrate to sufficient depths to affect the growth of such large trees as Eucalypts, and it may be that the particular condition which operates against the growth of large trees also serves to exclude bacteria and earthworms.

Where a soil is water-logged for a great portion of the year the growth of trees is likely to be prevented, but that is more of a local condition, and does not apply to many of the large treeless areas in this State.

Brief Conclusions.

It is thought that the various matters briefly alluded to in this Address are sufficient to show that the growth and distribution of native plants are regulated by many factors, and that, therefore, it is not possible to say definitely what a soil may produce without knowing all the facts governing its situation and accompanying conditions. A chemical analysis may disclose what food supplies a soil contains, and what it may be able to produce if certain attendant conditions exist, but before a final opinion can be expressed, questions relating to temperature, topography, rainfall, moisture or humidity, aspect, drainage and all local details must be investigated. The natural vegetation of any area is the best index as to what such a locality will produce. Subject to climate, the geological formation is a most important factor in regulating the growth and distribution of plants, and this is made manifest by the accordance in the changes of plant associations and of the rock formations. For countless ages the native flora has investigated the chemistry and physical characters of the soil in Nature's laboratory, taking into consideration every factor that affects or governs the position, and the result of this wonderful process is available for our study and our benefit in the indigenous vegetation which for so long has been allowed to work out its own destiny unmolested by invasions of either fresh fauna or flora. Clearly, therefore, it behoves us to take full advantage of this wonderful wealth of information which has been so bountifully supplied, and this can be best achieved by a careful botanical and soil survey of our State so far as is reasonably possible.

Some of the older members of the Society were then invited by the President to speak regarding the doings of the Society in its early days.

Mr. J. J. Fletcher referred in particular to two special meetings held by the Society: (1) The meeting, at the invitation of the Hon. William Macleay, on 31st October, 1885, on the occasion of the opening of the Linnean Hall at Elizabeth Bay. This was the one and only occasion on which Sir William made public reference to anything he himself had done for the Society. After giving a résumé of the Society's history to that date (1885), all he said of what he himself had done was contained in the following few simple words: "The necessity, however, for more room, and I may add less noise, has induced me to build the edifice we are now assembled in, which I beg to present, such as it is, to the Society for the period of 89 years, the unexpired term of my original lease of the ground for 99 years." The President (Professor Stephens) took advantage of the opportunity to recount something of what Sir William had done for the Society and of expressing the ardent gratitude of the members. (2) The special meeting on 22nd June, 1889, when Sir William was the guest of the members, at which a bust of Sir William, executed in marble by Signor Simonetti, was dedicated "to the perpetual remembrance of the singular services which have been rendered to the Society by their distinguished and munificent fellow member, Sir William Macleay, Knight."

Mr. Fletcher also called special attention to the great amount of secretarial and editorial work which Sir William did during the years 1879-1885, in his capacity as Honorary Secretary of the Society.

Dr. T. Storie Dixson, Mr. A. G. Hamilton and Mr. W. W. Froggatt recounted some of their early recollections of the Society.

Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheets for the year 1924, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that they be received and adopted, which was carried unanimously.

No nominations of other Candidates having been received, the President declared the following elections for the ensuing Session to be duly made:—

President: Mr. H. J. Carter, B.A., F.E.S.

Members of Council: Dr. W. R. Browne, Mr. R. H. Cambage, F.L.S., Professor H. G. Chapman, M.D., B.S., Dr. E. W. Ferguson, Mr. A. R. McCulloch and Dr. H. S. H. Wardlaw.

Auditor: Mr. F. H. Rayment, F.C.P.A.

A cordial vote of thanks to the retiring President was carried by acclamation.

Linnean Society of New South Wales

GENERAL ACCOUNT. Balance Sheet at 31st December, 1924.

LIABILITIES.	£ s. d.	£ s. d.
Capital: Amount received from Sir William Macleay during his lifetime	14,000 0 0	
Further sum bequeathed by his will	6,000 0 0	
		20,000 0 0
Contingencies Reserve		400 0 0
Income A/c at 31st December, 1924		77 18 7
Commercial Banking Coy. of Sydney, Ltd.		5,312 1 5
		£25,790 0 0

ASSETS.	£ s. d.	£ s. d.
Society's Freehold		11,000 0 0
Investments: Commonwealth Loans	9,780 0 0	
Loans on Mortgage ..	5,000 0 0	
		14,780 0 0
Cash in hand		10 0 0
		£25,790 0 0

INCOME ACCOUNT. Year Ended 31st December, 1924.

	£ s. d.	£ s. d.
To Salaries, Wages, and Allowances ..		1,077 8 4
„ Printing Publications	407 7 0	
„ Illustrations	151 3 9	
		558 10 9
„ Rates and Insurance		282 19 6
„ Postage	47 4 2	
„ Telephone	19 12 8	
„ Audit	7 7 0	
„ Printing and stationery	31 12 10	
„ Expenses	39 17 0	
„ Petty Cash	41 16 11	
„ Bank Expenses	2 7 7	
		189 18 2
„ Premises A/c (Macleay House)		627 5 1
„ Library and bookbinding		119 5 9
„ Appropriation: Contingencies Reserve		11 11 0
„ Balance to 1925		77 18 7
		£2,944 17 2

	£ s. d.	£ s. d.
By Balance from 1923		396 2 0
„ Subscriptions: 1924	145 19 0	
Arrears	8 8 0	
In advance	4 4 0	
		158 11 0
„ Entrance Fees		11 11 0
„ Interest on investments		701 3 0
„ Rents		261 3 4
„ Sales (including 100 copies of Proceedings purchased by Government of N. S. Wales) ..		186 2 9
„ Fellowships A/c (surplus income transferred)		1,230 4 1
		£2,944 17 2

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Auditor.
21st February, 1925.

J. H. CAMPBELL,
Hon. Treasurer.
Sydney, 23rd January, 1925.

LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1924.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	35,000	0	0	Commonwealth Loans	7,820	0	0
Surplus Income capitalised	9,466	13	4	Loans on Mortgage	36,580	0	0
				Commercial Banking Coy.	66	13	4
	£44,466	13	4		£44,466	13	4

INCOME ACCOUNT. Year Ended 31st December, 1924.

	£	s.	d.		£	s.	d.
To Salaries of Linnean Macleay Fellows	1,433	6	8	By Interest on Investments	2,814	19	1
„ Fellows' Subsidies	84	15	0				
„ Capital A/c	66	13	4				
„ General A/c	1,230	4	1				
	£2,814	19	1		£2,814	19	1

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,
Auditor.

21st February, 1925.

J. H. CAMPBELL,
Hon. Treasurer.

Sydney, 23rd January, 1925.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1924.

LIABILITIES.	£ s. d.	ASSETS.	£ s. d.	£ s. d.
Amount bequeathed by Sir Wm. Macleay	12,000 0 0	Commonwealth Loans		14,400 0 0
Accumulated Income capitalised	2,000 0 0	Cash: Commercial Banking Coy.	407 18 3	
Income A/c at 31st December, 1924	928 11 5	Government Savings Bank ..	114 13 2	
		In hand	6 0 0	
				528 11 5
	£14,928 11 5			£14,928 11 5

INCOME ACCOUNT. Year Ended 31st December, 1924.

	£ s. d.		£ s. d.
To Salary and Wages	592 8 11	By Balance from 1923	828 6 1
„ Expenses	21 10 7	„ Interest on investments	728 7 10
„ Petty Cash	14 3 0		
„ Balance to 1925	928 11 5		
	£1,556 13 11		£1,556 13 11

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Auditor.

21st February, 1925.

Sydney, 23rd January, 1925.

J. H. CAMPBELL,
Hon. Treasurer.

THE *LORANTHACEAE* OF AUSTRALIA. Part vi.

By W. F. Blakely, Botanical Assistant, National Herbarium, Sydney.

(Plates i—xii.)

[Read 25th March, 1925.]

Subgenus DENDROPHTHOE.

Petals 5 or 6, united, without basal folds. Filaments not barbed.

Sect. Lysiana.

Flowers solitary, binate or in clusters of 3-5, with or without a common peduncle. Corolla usually 6-merous.

i. Leaves terete or nearly so.

1. Flowers 2 cm. long, solitary or in pairs, without a common peduncle. Pedicels elongated. Leaves usually alternate, single or fascicled ..... 32. *L. Murrayi.*
Flowers 1.3-1.5 cm. long ..... var. *parviflora.*

1a. Flowers binate, pedicellate, the common peduncle elongated. Leaves opposite, sub-filiform ..... 33. *L. Mitchellianus.*

2. Flowers in pairs or clusters. Common peduncle very short or almost obscure. Leaves firm, somewhat flexuose, acute ..... 34. *L. Casuarinae.*

ii. Leaves flat.

1. Flowers green at the top, red at the base. Leaves opposite or sometimes alternate, narrow-oblong, penninerved, 3-8 cm. long ..... 35. *L. Exocarpi.*

2. Leaves slender, 10-15 cm. long ..... (*a*) var. *tenuis.*

1a. Flowers yellow. Leaves narrow, 3-6 cm. long ..... (*b*) var. *flavescens.*

2a. Leaves cuneate-spathulate, venulose, 2-3 cm. long ..... (*c*) var. *venulosa.*

1b. Flowers red, 3.5 cm. long. Leaves narrow, oblong to falcate-lanceolate. ..... (*d*) var. *coccineus.*

1c. Flowers 2.5 cm. long. Leaves spathulate, 6-10 cm. long. (*e*) var. *spathulata.*

Sect. Amylotheca.

Inflorescence cymose or subumbellate. Flowers in triads, the central flower sessile. Style capillary. Apex of ovary prismatic.

1. Leaves broad, oblong to lanceolate, veins reticulate .... 36. *L. dictyophlebus.*

Ser. *Eudendrophthoe.*

Flowers binate, racemose or in axillary clusters. Corolla inflated in the middle. Petals 5, rarely 6.

i. Young shoots and inflorescence glabrous.

1. Flowers in pairs on slender pedicels. Leaves petiolate, alternate, lanceolate ..... 37. *L. acacioides.*

2. Flowers racemose. Leaves opposite, sessile, cordate .. 38. *L. homoplasticus.*

ii. Young shoots and inflorescence pubescent, except in var. *glabrescens.*

1. Indumentum ferruginous. Racemes 10—20-flowered ..... 39. *L. vitellinus.*

1a. Racemes strictly glabrous ..... var. *glabrescens.*

2. Indumentum hoary-tomentose. Racemes 3—7-flowered. Corolla minutely pubescent inside ..... 40. *L. odontocalyx.*
2a. Indumentum rufous-cinereous. Corolla glabrous inside ..... var. *propria.*

Ser. *Benthamina.*

Flowers red, binate, ferruginous; bracteate pedicels rarely longer than the calyx. Corolla cleft nearly to the base on one side only; petals 5, very short.
1. Leaves ovate to obovate, thick. Buds slender, arcuate, rust-coloured. ..... 41. *L. alyxifolius.*

Subgenus Dendrophthoe Blume.

Blume, *Fl. Javae*, 1829, 13; Mart., *Flora*, 1830, 109; Engl. in Engl. et Prantl, *Pflanzenfam.*, Nachtr. ii, iv, 1897, 129.

Petals, 5 or 6, united, without basal folds. Filaments not barbed.

Sect. Lysiana (Van Tiegh.).

Engler, *l.c.*, 126.

Flowers solitary, binate, or in clusters of 3-5, with or without a common peduncle. Corolla inflated towards the middle, unequally 6-cleft. Filaments diminishing upwards. Anthers linear, acute, becoming curved as the flower fades. Style usually terete; stigma subcapitate. Fruit ovoid to globose, red; endosperm slightly furrowed; embryonic cotyledons very short, lanceolate, slightly spreading; hypocotyl often long and verrucose, with suctoral papillae; embryonic cotyledons withdrawn from the endosperm on germination. Erect or pendulous glabrous shrubs with terete, or narrow venulose leaves; union ball-like, without adventitious roots.

The species belonging to Sections Lysiana and Amylotheca are placed under *Elytranthe* by Engler (in Nachtr. *l.c.*), but I have transferred them to *Loranthus* for reasons partly expressed under Section Neotreubella (These Proceedings, xlvii, 1922, 7). The only characters which seem to vary unessentially from those of *Elytranthe*, are the corolla and the anthers. But as the same characters are also peculiar to some species of *Loranthus*, in contradistinction to the two or more celled ovary of *Elytranthe*, it seems to me that the species referred to are more closely allied to *Loranthus* than to *Elytranthe*. It must be borne in mind that the ovary of various species of *Loranthus*, although 1-celled, sometimes contains 2 embryos, and is apt to be mistaken for a 2-celled ovary.

32. Loranthus Murrayi F. v. M. et Tate. Plate i.

Mueller et Tate, *Trans. Roy. Soc. S.A.* vi, 1883, 109; Tate, *Handbook Fl. Extra-Trop. S.A.* 1890, 106.—*Elytranthe Murrayi* (F. v. M. et Tate), Engler, *l.c.*

Glabrous, leaves alternate, semi-terete, slender, not exceeding two inches in length, sometimes attenuated at the base; flowers mostly solitary, sometimes in pairs on flattened, shortly winged pedicels, about ½-inch long, without a common peduncle; bracts unequally bilobed, conspicuous, decurrent on the pedicels; calyx-tube prominent, glaucous, its border truncate and obscurely toothed; petals usually 6, about 10 lines long, united to about two-thirds their length into a slightly dilated tube; corolla tube pale-yellow; segments linear-lanceolate, yellow below, pale rose above; stigma capitate; style and filaments brown; anthers adnate, broadly linear; unripe fruit globular, glaucous.

Supplementary Notes to the Description.

Branches virgate, lenticular, and apparently pendulous; mode of attachment unknown. Leaves opposite, alternate, or more often fascicled at the intersection

of the abortive branches, compressed, linear, contracted at the base or nearly terete. Flowers rarely in pairs; bracts sometimes exceeding the calyx, and occasionally semi-foliaceous and more decurrent than in any of the allied species. Buds slightly curved, but occasionally much curved, usually acute, inflated upwards; corolla 2 cm. long; style angular, with a raised circular disc at its base; cotyledons unknown.

Range.—Up till now this species has only been recorded for South Australia and Western Australia; it is now recorded for the first time as an addition to the flora of New South Wales and Queensland from the following localities:

New South Wales.—Paldrumatta Bore, Wilcannia (on *Acacia aneura*); Momba; Rowenia Tank, five miles from Mootwingie Hills (on *L. Exocarpi*); Urisino-Thurloo Downs, Paroo River (on *Acacia excelsa, Heterodendron oleaefolium*).

Queensland.—Near Charleville (on *Eremophila Mitchelli*).

South Australia.—Spencer's Gulf; north-east part of Lake Torrens Basin; Upper Arkaringa Valley (on *Acacia salicina*); Musgrave Range; Idyaka, near Termination Hill; Aroona Range, the type locality; Albergia River; Mount Lyndhurst; near Tarcoola.

Western Australia.—Upper Gascoyne River.

Affinities.—Besides its affinity with *L. linearifolius* (*L. Mitchellianus*, as pointed out by Professor Tate, *l.c.*), some of the very narrow leaved forms of *L. Exocarpi* var. *tenuis* resemble it in the shape of both the leaves and flowers, but the pedicels are very dissimilar. To *L. Gaudichaudi* DC., it is allied in its spherical fruits, and somewhat in the leaves, especially the short, compressed leaved forms, but the flowers are totally different. *L. Murrayi* is distinguished from all the Australian species by its decurrent bracts which give the pedicels a slightly winged appearance.

Hosts.—Leguminosae: *Acacia aneura* F. v. M., *A. excelsa* Benth., *A. salicina* Lindl. Sapindaceae: *Heterodendron oleaefolium* Desf. Myoporaceae: *Myoporum Mitchelli* Benth.

LORANTHUS MURRAYI, var. PARVIFLORA S. Moore.

Journ. Bot. xxxv, 1897, 170, as *L. miniatus; Journ. Linn. Soc. Lond.* xxxiv, 1898-1900, 225-6.

Flowers pale greenish below, yellow or orange above. Berries dark red. Near Goose's Soak and Kilkenny Soak, Western Australia.

The author refers to this plant as follows: "Since writing my memoir (vide loc. cit.) on the camel-fodder plants of West Australia, I have had the opportunity of seeing at Kew, specimens of *L. Murrayi*, the affinity of which, with my supposed new species, *Loranthus miniatus*, I have already alluded to. I find that the Elder Expedition specimen referred to *L. Murrayi* has the peculiar habit of mine, viz., leaves crowning subobsolete branches; and as the flowers, except for their reduced size, are essentially similar to those of typical *L. Murrayi*, it would be better to consider the West Australian plant as a small-flowered variety of the South Australian plant."

I have not seen this variety, which appears to differ from the typical form chiefly in the smaller pedicels and flowers.

Synonym.—*L. miniatus* S. Moore.

Host.—Leguminosae: *Acacia* sp.

33. Loranthus Mitchellianus, n. sp. Plate ii.

Hook., *Mitch. Trop. Aust.*, 1848, 102, as *L. linearifolia;* Walp., *Rept. Bot.* ii, 1851-52, 730; Benth., *B. Fl.* iii, 1866, 392; Tate, *Handb. Fl. Ext.-Trop. S.A.*, 1890, 106; Moore et Betche, *Handb. Fl. N.S.W.*, 1893, 228; Bail., *Fl. Q'land*, v, 1902, 1379.

The name *L. linearifolius* is already occupied by a Chilian species (vide Bert., Merc. Chili, 1829, ex *Am. Journ. Sci.* xxiii, 1833, 95). Therefore, I propose the name *Mitchellianus*, in honour of the collector, Lieut.-Col. Sir Thomas Mitchell, Surveyor-General of New South Wales, 1845.

The following is a translation of the original description: Leaves glabrous, carnose, terete, linear-filiform, acute; peduncles axillary, shortly biflorous; calyx cylindrical, truncate, contracted; petals 6, linear, cohering above the base.

Supplementary Notes to the Description.

Pendulous shrubs with long, slender, glabrous, reddish-brown branches, covered with numerous orbicular lenticels. Union ball-like; leaves chiefly opposite, filiform, semiterete, acute, 2-8 cm. long, straight or curved, the apex sometimes uncinate. Flowers glabrous, red, tipped with green or yellow, in pairs on slender, axillary, and sometimes terminal peduncles; the common peduncle slightly thicker than the pedicels, 3-9 mm. long, the pedicels longer, flat, broader towards the top. Bracts cordate, acute, or truncate, and occasionally bilobed, pale coloured, decurrent on the pedicels. Calyx cylindrical, with a minute obscurely denticulate limb. Buds 2-2½ cm. long, inflated in the middle to a diameter more than twice the size of the contracted, curved upper portion. Corolla semi-transparent, divided to about one-third of its length into 6 slightly unequally acute petals, which are narrower at the attachment of the filaments, and considerably broader towards the base, deflexed or recurved after anthesis. Filaments of unequal length, the free portion much larger than the adnate portion. Anthers adnate, oblong, linear, 2 mm. long; style terete, curved in bud, the base conoidal, and the most persistent on the fruit of all the Australian species. Stigma small, scarcely capitate. Fruit elliptical to ovate-oblong, 12 mm. long, whitish to pale pink. In a dry state they resemble the dried fruits of *Persoonia pinifolia.* Seeds elliptical, slightly sulcate; the endosperm almost separable into several divisions without laceration, as in the seeds of *L. dictyophlebus;* hypocotyl slender; suctoral disc flat, surrounded by a fringe of rather long green papillae; cotyledons not seen.

The type locality is on the Narran River, in the vicinity of Angledool; it was collected by Mitchell, on March 24th, 1846 (vide Mitchell's Tropical Australia, 101-2. "A beautiful new Loranth, with red flowers tipped with green was parasitic on *Capparis lasiantha.*").

Economic Uses.—Stock Inspector A. W. Mullen reports that stock are very fond of this species, and that in many cases they will not eat the tree on which it grows. Spencer L. Moore (*Journ. Bot.* xxxv, 1897, 170) includes this species amongst the Camel fodder plants of Western Australia.

Synonyms.—*L. linearifolius* Hook., *Elytranthe linearifolius* (Hook.) Engler.

Range.—*L. Mitchellianus* is almost exclusively a desert species, inhabiting the drier parts of the continent, and it is frequently parasitic upon *Acacia* and other soft-wooded plants. Its present range extends from Coonabarabran, in New South Wales, to Irwinbank, in Queensland, and, crossing the central portion of South Australia, it makes its appearance in Western Australia at Murrin Murrin,

in the Great Victoria Desert, and at Cue, in the Gibson Desert, and then extends in a north-westerly direction from Cue to Sharks Bay.

Affinities.—Near *L. Murrayi* F. v. M. et Tate, from which it differs in the geminate flowers, smaller bracts, and differently shaped fruits.

Its affinity to *L. Casuarinae* lies chiefly in the similarity of the flowers, and somewhat in the leaves. The chief character of differentiation between these species is the furcate peduncle of *L. Mitchellianus*, which is always well developed, as against the very short or imperfectly developed common peduncle of *L. Casuarinae;* there is also a marked difference in the leaves, those of the latter are always more rigid and thicker than those of the former.

The very delicate and slender forms of *L. Exocarpi* var. *tenuis* show a close resemblance to *L. Mitchellianus;* the arrangement of the flowers, however, sharply separates them, as in *L. Casuarinae;* and the base of the style is not enlarged to the same extent as in *L. Mitchellianus.*

Hosts.—Casuarineae: *Casuarina* sp. Proteaceae: *Grevillea striata* R. Br., *Hakea Preissii* Meissn. Capparidaceae: *Capparis lasiantha* R. Br., *Apophyllum anomalum* F. v. M. Leguminosae: *Acacia aneura* F. v. M., *A. Burkitti* F. v. M., *A. colletioides* A. Cunn., *A. excelsa* Benth., *A. sentis* F. v. M. Rutaceae: *Flindersia maculosa* F. v. M. Myoporaceae: *Eremophila Mitchelli* Benth.

34. Loranthus Casuarinae Miq. (*non* Ridley). Plate iii.

Lehm., *Pl. Preiss.*, 1844-5, 279; Walp., *Rept. Bot.* v, 1845-6, 938; Mueller, *Rept. Burdk. Exped.*, 1860, 18.

The following is a translation of the original description: Glabrous, branches terete; leaves subopposite or opposite, terete-filiform, succulent, coriaceous, shortly mucronate, glabrous. Flowers axillary, pedicellate, solitary or in pairs on the common peduncle. Calyx-limb obscurely denticulate. Petals 6, narrow-linear, cohering and terete-clavate in bud, at length free. Stamens inserted on the upper half of the petals; anthers linear, of equal length. Style filiform.

Parasitic on *Casuarina*, on the plains above Perth, 13 May, 1839, Herb. Preiss, No. 1615. Branches terete; branchlets trichotomous or alternate, smooth, dark ashy-grey, easily broken. Leaves somewhat rigid, green, terete, subopposite, rarely perfectly opposite, wrinkled when dry, straight or subflexuose, terminating in a short mucro, 5-10 cm. long, 1-3 mm. thick. Flowers axillary, solitary or in pairs; the common peduncle 2-4 mm. long; pedicels about 1 cm. long; basal bract ovate, shortly acute, concave, carnose. Buds cylindrical or subclavate, slightly curved towards the top. Calyx 4 mm. long, obconic, the limb pale, obscurely denticulate. Petals linear, the apex dilated and acute. Anthers 7 mm. long.

Bentham reduced it to a synonym of *L. linophyllus* Fenzl. I have not seen Preiss. No. 1615, but from the description it seems to belong to the Dendrophthoe group rather than to Euloranthus. I am also influenced in arriving at this decision by the investigation of specimens collected by Mr. W. V. Fitzgerald, near Perth, the type locality, with the following note by Mr. Fitzgerald: "Flowers from red to greenish or yellowish red. Fruit scarlet, with viscid pulp." The flowers are identical with those of *L. Exocarpi* Behr, with the characteristic short, thick, common peduncle, giving rise to two short, deflexed pedicels. The leaves are terete, straight or flexuose, ending in a short mucro. The branches are also very similar to those of *L. Exocarpi*, and quite distinct from the branches of *L. linophyllus.* I received the loan of another specimen from Professor Ewart,

Melbourne Herbarium, which was labelled as follows: *Loranthus Casuarinae* Miq., Red Point, Western Australia, Oldfield; *L. linophyllus* Fenzl. The latter name is in Baron von Mueller's handwriting; the former, probably that of the collector, Oldfield. The leaves are quite glabrous, mostly opposite, compressed-terete, acute and firm, 3 inches long, and articulate on a rather broad, circular base. Flowers reddish, with the same characters as *L. Exocarpi*.

I have not seen any other specimens like the above, especially in regard to the terete, flexuose, acute leaves, and they are unlike other slender forms of *L. Exocarpi*. This form, no doubt, is *L. Casuarinae* Miq.

James Drummond (Notes on the Botany of Western Australia, *Hooker's Journ. Bot.* v, 143) refers to this species as follows: "On Messrs. Davis and Walcott's station on the Greenough are two new species of *Loranthus*, both parasitic on the 'Raspberry Jam.' One of them resembles *L. Preissii* in foliage, but the tubes of the flowers are longer and narrower, and of a different colour, the lower part of the tube red, the upper yellow; they are also of a different shape, having a sort of ringent mouth."

Mueller (*Rept. Burd. Exped.*, 12) makes the following comment on this species: "*L. Casuarinae* Miq. is as yet in its normal form with cylindrical leaves only found in the Western extra-tropical portion of our continent, reaching to Chamber's Creek eastward. But it appears that only the flat leaves distinguish *L. Exocarpi*, whilst in a specimen gathered near Lake Torrens the leaves are semiterete. If the very characteristic black berry of *L. Exocarpi* is identical with that of *L. Casuarinae* we cannot hesitate to combine both."

In reference to the fruit of *L. Casuarinae*, Mr. W. V. Fitzgerald states that it is scarlet. But as the fruit of *L. Exocarpi* is red before it turns black, the fruit of *L. Casuarinae* may change from red to black also. This point can only be settled by further field investigation. I quite agree with Mueller that the main difference between *L. Casuarinae* and *L. Exocarpi* is in the leaves. All the other characters appear to be the same in both species. *L. Casuarinae* Miq. is the oldest name; it was described two years before *L. Exocarpi* Behr., but as the latter name has been in use for the last seventy odd years, and as it is readily distinguished from *L. Casuarinae* in the leaves, I think it should also be recognised as a distinct species.

Synonym.—*L. linophyllus* Benth. (*non* Fenzl), *Elytranthe Casuarinae* (Miq.) Engler.

Range.—*Western Australia*: Perth (on *Casuarina* sp., Preiss, No. 1615, the type); Comet Vale (on *Casuarina glauca*); Greenough River (on *Acacia acuminata*); Red Point.

South Australia: Chamber's Creek; Lake Torrens. I have not seen these specimens, but they appear to be referable to this species.

Hosts.—Casuarineae: *Casuarina glauca* Sieb. Leguminosae: *Acacia acuminata* Benth.

35. Loranthus Exocarpi Behr. Plate iv.

Behr, *Schlecht. Linnaea*, xx, 1847, 624; Walp., *Rept. Bot. Syst.* i, 1848-9, 364; Miq., *Ned. Kruidk. Arch.* iv, 1856, 105; Benth., *B. Fl.* iii, 1866, 392; Etting., *Über die Blatts. der Lor.*, iii, Figs. 14, 15; Muell., *Key Vic. Pl.* i, 1887-8, 273; Eng., Engl. et Prantl, *Pflzfam.* iii, i, 184, Fig. 126; Moore and Betche, *Fl. N.S.W.*, 1896, 228; Bail. *Qland Fl.* v, 1902, 1397; Tate, *Handb. Fl. Ext.-Trop. S.A.*, 106.

I have not seen the original description; those already referred to are very similar to each other, and for preference I give that of Bentham.

Glabrous. Leaves mostly opposite, but here and there alternate, from oblong-cuneate to narrow-linear, but always flat, obtuse, narrowed into a petiole, mostly 1½ to 2½ inches long, rather thick, often triplinerved. Flowers axillary, pedicellate, solitary or in pairs, on thick pedicels, sessile or more rarely borne on a very short common peduncle. Calyx border obscurely toothed. Petals usually 6, above 1 inch long, united to about one-third of their length. Anthers adnate, linear.

Supplementary Notes.—Usually pendulous shrubs with a ball-like union, often forming dense drooping masses; branches terete, reddish-brown with numerous lenticels, 2-3 feet long, but sometimes longer. Leaves of the typical form 1-3 inches long, ¼-½ inch broad, quite glabrous, penninerved, never strictly triplinerved. Flowers in axillary clusters of 3-4, or more often solitary, or in pairs on a very short, thick peduncle; the pedicels twice as long as the calyx, the top of which is somewhat rounded into a slightly thickened disc. Bracts small, usually cordate, acute, occasionally truncate, or minutely trilobed and spreading. Calyx very narrow, cylindric, the limb small, irregularly denticulate. Buds curved, acute, inflated in the middle, usually more than 1in. long, the lower portion reddish, green towards the top. Petals 5 or 6, linear-lanceolate, unequally cleft, with a small thickened callosity at the base, the lower one divided to about the middle of the corolla, the upper ones scarcely to the middle, all abrupty deflexed near the attachment of the filaments. Filaments reddish, though sometimes yellowish or greenish, the free portion about the same length as the very narrow, curved anthers; the cells of the latter very narrow, membranous and fragile. Style faintly angular, and when enclosed in the bud, bent from one side of the corolla to the other in a distinct wave, and actually shorter than the anthers, pale green in the lower portion, reddish towards the top; stigma ovate, not large. Disc circular, very small. Fruit elliptical, 8-10 mm. long, bright yellow to reddish, turning black when over-ripe; seeds ovate-elliptical, longitudinally 5-furrowed; hypocotyl verrucose in the dormant seed, about half the length of the entire embryo; embryonic disc slightly enlarged; endosperm and embryo green, the former hard, the latter nail-shaped; embryonic cotyledons very short, scarcely 1 mm. long, and about as broad, somewhat emarginate. On germination the hypocotyl is minutely verrucose with suctoral papillae and it becomes elongated, sometimes exceeding 2 cm.; suctoral disc domed, the surface microscopically papillose, and with a ring of longer papillae at its base, which soon falls. The cotyledons appear to withdraw from the endosperm on germination.

The life history of *L. Exocarpi* is ably expounded by C. C. Brittlebank (THESE PROCEEDINGS xxxiii, 1908, 650). The seeds are figured in various stages of development, and numerous sections of the plant are shown illustrating its attachment with the various hosts.

The leaves of *L. Exocarpi* (figured by Ettingshausen, *Über die Blatts. der Lor.*, Tab. iii, fig. 14, 15) are strikingly like many of the leaves of the typical form; they are narrow-oblong to narrow-spathulate, 2-2½ inches long.

The type comes from Barossa, where it was collected by Dr. Hans Herman Behr between 1841 and 1846. Barossa is a small mining township situated between the South Para River and Sandy Creek about 25 miles N.N.E. from Adelaide.

Synonyms.—*Loranthus angustifolius* R. Br.; *Elytranthe Exocarpi* (Behr.) Engler.

Range.—Found widely in all the States of the mainland. Like other interior species, it follows closely the saline country and shows considerable variation throughout its wide range. This fact was noted by Bentham, for he says: "the

narrow-leaved forms are common in the south, and the broad-leaved forms are found in the north." As will be seen subsequently, I have separated the various forms into distinct varieties, as some are particularly striking, especially in relation to the shape, length and venation of the leaves, and also in the colour of the flowers.

Affinities.—This species shows affinity with *L. Mitchellianus* in the flowers and their arrangement, but the common peduncle and pedicel are much longer in the latter, the leaves of *L. Mitchellianus* are very narrow, almost terete, and therefore they are very dissimilar from those of *L. Exocarpi.*

Some of the narrow-leaved forms of *L. acacioides* A. Cunn. are likely to be confused with similar leaves of this species, unless the opposite character of the leaves of *L. Exocarpi* is borne in mind, and also its shorter and stouter pedicels, in contradistinction to the slender pedicels of *L. acacioides.*

Stock Food.—Mr. E. Officer, of Zara, near Hay, reports that sheep eat the leaves of *L. Exocarpi* readily.

Hosts.—This is a most polyphagous species as the following hosts will show. Pinaceae: *Callitris cupressiformis* Vent. Casuarineae: *Casuarina stricta* Ait., *C. Luehmanni* R. T. Baker. Moraceae: *Ficus orbicularis* A. Cunn. Santalaceae: *Santalum lanceolatum* R. Br., *Fusanus acuminatus* R. Br., *Exocarpus cupressiformis* Labill., *E. aphyllus* R. Br. Loranthaceae: *Loranthus Quandang* Lindl., *L. Miquelii* Lehm., *L. pendulus* Sieb., *L. miraculosus* Miq., *L. Preissii* Miq. Proteaceae: *Hakea lorea* R. Br., *H. Ivoryi* Bail. Chenopodiaceae: *Chenopodium nitrariaceum* F. v. M. Leguminosae: *Acacia aneura* F. v. M., *A. Burkitti* F. v. M., *A. calamifolia* Sweet., *A. binervosa* DC., *A. dealbata* Link., *A. decurrens* Willd., *A. excelsa* Benth., *A. homalophylla* A. Cunn., *A. implexa* Benth., *A. melanoxylon* R. Br., *A. Oswaldi* F. v. M., *A. pendula* A. Cunn., *A. pycnantha* Benth., *A. salicina* Lindl., *A. sentis* F. v. M., *A. sericata* A. Cunn., *A. tetragonophylla* F. v. M., *A. retinodes* Schl., *Cassia Sturtii* R. Br., *C. pteroloba* F. v. M., *Bauhinia* sp., *Bossiaea Battii* F. v. M., *Templetonia egenea* Benth. Capparidaceae: *Capparis Mitchelli* Lindl., *Apophyllum anomalum* F. v. M. Pittosporaceae: *Pittosporum phyllyraeoides* DC., *Bursaria spinosa* Cav. Rosaceae: (*e*) *Prunus cerasus* L., (*e*) *P. Persica* L., (*e*) *P. amygdalus* L., (*e*) *P. domestica* L., (*e*) *Pyrus Cydonia*, (*e*) *P. communis* L. Rutaceae: *Geijera parviflora* Lindl., (*e*) Lisbon Lemon. Sapindaceae: *Eremocitrus glauca* Swingl., *Heterodendron oleaefolium* Desf. Violaceae: *Hymenanthera Banksii* F. v. M. Myrtaceae: *Angophora lanceolata* Cav., *Eucalyptus populifolia* Hook., *E. rostrata* Schl., *Melaleuca* sp. Oleaceae: (*e*) *Olea Europaea* L. Apocynaceae: (*e*) *Nerium Oleander* L. Solanaceae: (*e*) *Nicotiana glauca* L. Myoporaceae: *Eremophila Brownii* F. v. M., *E. Duttonii* F. v. M., *E. Freelingii* F. v. M., *E. Sturtii* R. Br. Rubiaceae: *Canthium oleifolium* Hook.

(*e*) Denotes exotic plants.

(*a*) Var. TENUIS, n. var. Plate v.

Frutex ramis glabris longis et tenuibus lenticulatis. Folia angusto-linearia recta vel curva, media costa prominento, 10-15 cm. longa. Flores nonnumquam in parvis cymis. Gemmae tenues; petali glauco-virides; corolla rubra; antherae aliquanto longae. Stylus tenuis, plerumque cum corolla caducus; stigma parvum, ovatum. Fructus maturus sanguineus, ovatus, circiter 6 mm. × 5 mm.

Branches glabrous, long and slender, lenticulate; leaves narrow-linear, straight or curved, the median nerve prominent, 10-15 cm. long. Flowers sometimes in small clusters; buds slender; petals sea-green; corolla red; anthers rather long;

style slender, usually falling off with the corolla; stigma small, ovate. Fruit blood-red when ripe, ovate, about 6 mm. × 5 mm.

This is probably the narrow leaved form referred to by Bentham. It is dispersed over four States.

Range.—*Victoria*: You Yangs, near Melbourne; Grampians; Dumosa, near Mt. Wycheproof; near Charlton; Fairview; Dimboola. *South Australia*: Bowerton; York Valley; Ooldea. *New South Wales*: Zara; Griffith; Eangonia, via Dubbo; Belmont, Lake Macquarie; West Bogan; Coolabah; Byrock; Glendon; Baeramia, Denman; Gungal; Narrabri; Pilliga; 40 or 50 miles N.W. of Collarenebri; Boggabri; Mungindi. *Queensland*: Stannary Hills.

Hosts.—Casuarineae: *Casuarina glauca* Sieb., *C. lepidophloia* F. v. M., *C. paludosa* Sieb., *C. Luehmanni* R. T. Baker. Loranthaceae: *Loranthus linophyllus* Fenzl. Santalaceae: *Exocarpus aphylla* R. Br., *E. cupressiformis* Labill. Pittosporaceae: *Bursaria spinosa* Cav., *Pittosporum phyllyraeoides* DC. Proteaceae: *Hakea vittata* R. Br. Leguminosae: *Acacia excelsa* Benth., *A. Oswaldi* F. v. M., *Cassia eremophila* A. Cunn., *C. Sturtii* R. Br., *Jacksonia scoparia* R. Br. Sapindaceae: *Eremocitrus glauca* Swingl., *Heterodendron oleaefolium* Desf. Rutaceae: *Geijera parviflora* Lindl.

(*b*) Var. FLAVESCENS (Muell.) Miquel. Plate v.

Ned. Kruidk. Arch. iv, 1856, 105; F. v. M. and Tate, *Trans. Roy. Soc. S.A.* xvi, 1892, 360, as var. *lutea*, without a description.

The following is a translation of the original description: Flower tube yellow; leaves long and narrow, rather curved; branches divaricate.

No definite locality is quoted by Mueller for this variety, but there is reason for assuming that it came from the southern parts of the continent, probably from Victoria. Max Koch (*Trans. Roy. Soc. S.A.* vi, 1900, 83) states that "a form with yellow petals and green at the summit is often found."

Range.—*Victoria*: Near Mount Charlton. *New South Wales*: Nyngan (on *Acacia stenophylla*). *Queensland*: Knockbreak Station; Eidsvold (on *Casuarina Luehmanni*. Flowers tubular, of an orange colour, Dr. T. L. Bancroft). *South Australia*: Morphett Vale (petals bright lemon yellow, with green tips, C. F. Johncock, *Trans. Roy. Soc. S.A.* xxvi, 1901, 253); Mt. Lyndhurst; Cootanoorina (on *Acacia* sp.; the type of var. *lutea* F. v. M. and Tate, *l.c.* Leaves narrow lanceolate, to falcate lanceolate, obtuse, 1½ to 2½ inches long. Flowers the same as in *L. Exocarpi*, but yellow, shaded green). *Western Australia*: Comet Vale (on *Casuarina glauca*. Leaves linear as in var. *tenuis*, buds yellow, slender).

Differing from *L. Exocarpi* in the narrow leaves and yellow flowers.

Synonym.—*L. Exocarpi* Behr. var. *lutea* F. v. M. and Tate.

Hosts.—Casuarineae: *Casuarina glauca* Sieb., *C. Luehmanni* R. T. Baker. Leguminosae: *Acacia stenophylla* A. Cunn.

(*c*) Var. VENULOSA, n. var. Plate v.

Folia cuneato-spathulata aliquanto lata, fortiter venala nonnunquam bis-vel tripli-vernata. Flores recentes glauco-virides vertice, basi in colorem stramentum mergentes.

Leaves cuneate-spathulate rather broad, strongly veined, with a tendency to become bi- or tri-plinerved. Flowers when fresh, sea-green at the top, shading into straw-yellow at the base.

Range.—Cobar (on *Acacia colletioides*, J. L. Boorman, 5, 1918, the type). Archdeacon Haviland (THESE PROCEEDINGS xxxvi, 1911, 523) records a yellow flowering form from Cobar; between 16 and 34 miles from Bourke towards Cobar

(on *Acacia aneura*) with yellow flowers in May (vide R. H. Cambage, THESE PROCEEDINGS XXV, 1900, 597); Gunnedah; Narrabri (on *Heterodendron oleaefolium*); Warialda (on *Santalum lanceolatum*).

Hosts.—Santalaceae: *Santalum lanceolatum* R. Br. Leguminosae: *Acacia aneura* F. v. M., *A. colletioides* A. Cunn. Sapindaceae: *Heterodendron oleaefolium* Desf.

(*d*) Var. COCCINEUS (F. Muell.) Miquel.

Ned. Kruidk. Arch. iv, 1856, 105.

The following is a translation of the original description: Tube scarlet; leaves broadish, slightly curved; branches rather erect. Immature berry at first green, then red; mature black, globose, smaller than a cherry, containing a copious quantity of bird-lime. Flowering in summer.

The following is a copy of a label in Melbourne Herbarium in Mueller's handwriting: "*Loranthus Exocarpi* Behr., var. floribus coccini, on *Acacia retinoides*, *Casuarina*, and *Exocarpus*, Murray, F. Mueller, March, 1851." A second label is as follows: "*Loranthus Exocarpi* Behr, var. *rubra* (*Loranthus perfidiosus* Ferd. Mueller). In ramis *Exocarpus cupressiformis*, pes planties versus (?) Lat. Vit. L. Apr. 28th, 1848."

These, no doubt, are the specimens referred to by Miquel (*l.c.*) and probably constitute the type of var. *coccineus*, which appears to differ from the typical form in the colour of the flowers only. However, as fresh specimens are not available, I am inclined to uphold the variety. It will be a matter for local botanists to investigate, and ascertain if the characters are constant, and also whether there are other characters to distinguish it from the typical form.

Range.—It seems to be confined to South Australia.

The name *L. perfidiosus* is an herbarium one only, as is also var. *rubra*.

Hosts.—Santalaceae: *Exocarpus cupressiformis* Labill. Casuarineae: *Casuarina* sp. Leguminosae: *Acacia retinodes*. Schl.

(*e*) Var. SPATHULATA, n. var. Plate v.

Frutex ramis indivisis longis et tenuibus, haud divaricatis ut in typo. Cortex levis rubescens. Folia spathulata vel falcato-spathulata, obtusa, venis, nonnumquam vagis, sed plerumque prominentibus 6-10 cm. longis, petiolo fere 3 cm. longo. Flores minores quam in typo, curvi, siccati obscuro-rubri. Calyx dentatus longibus segmentis. Fructus oblongus, 13 mm. longus; basis styli persistens apud fructum.

Branches simple, long and slender, not divaricate as in the typical form. Bark smooth, brownish; leaves spathulate, or falcate-spathulate, obtuse, 6-10 cm. long, the petiole nearly 3 cm. long. Flowers smaller than the normal form, curved, drying a very dark red; calyx deeply toothed. Fruit oblong, 13 mm. long in a dry state, with the base of the style persistent upon it.

Range.—Confined to the Northern Territory, North Queensland, and North-West Australia.

North Queensland: Settlement Creek (on *Erythrophloeum Laboucherii*). Two of the leaves measure 8 × 4 cm., with three prominent, and three finer veins; Bacon Swamp (on *Eucalyptus* sp., the type); Lander Creek (on *Cassia Sturtii*, *Santalum lanceolatum*. Leaves 3-6 cm. long, spathulate, rather thick, obscurely veined. Buds stout, curved, 2 cm. long. *L. dictyophlebus* F. v. M., Ewart and Davies, *Fl. N.T.*, 88); 106 miles N. of Survey Camp iv (on *Acacia stipuligera*, *A. coriacea*); 20 miles N. of Tennant's Creek, MacDonnell Range (on *Acacia holosericea*); Kelly's Well, near Kelly's Creek (on *Eucalyptus pyrophora* var. *polycarpa*, *Acacia dictyophleba*. The common peduncle in the three specimens is

well developed, sometimes exceeding 4 mm. long). This is probably the variety referred to by Mueller (*Rept. Burdk. Exped.*, 12): "A variety with spathulate leaves I observed in Arnheim's Land and on the Gilbert River."[1]

Western Australia: Near Mount Agnes, Kimberley district (on *Santalum lanceolatum*).

Hosts.—Moraceae: *Ficus* sp. Santalaceae: *Santalum lanceolatum* R. Br. Leguminosae: *Acacia dictyophleba* F. v. M., *A. coriacea* DC., *A. holosericea* A. Cunn., *A. stipuligera*, F. v. M., *Cassia Sturtii* R. Br., *Erythrophloeum Laboucherii* F. v. M. Myrtaceae: *Eucalyptus pyrophora* Benth. var. *polycarpa* Maiden.

Sect. AMYLOTHECA (Van Tiegh.) Engler.

Engler, Engl. et Prantl, *Pflzfam.*, Nachtr., 1897, 126; Van Tiegh., *Bull. Soc. bot. Fr.* xli, 1894, 261.

Inflorescence cymose or subumbellate. Flowers in triads, the central flower sessile. Buds slightly curved, inflated in the middle and also at the base. Petals 6, abruptly deflexed. Filaments about as long as the very acute anthers. Anther cells very frail. Style capillary, curved or wavy in bud from one side of the corolla to the other. Stigma slightly enlarged. Apex of ovary prismatic in bud, but completely enclosed in the oval or globose fruit. Ovary one-celled. Embryonic cotyledons probably withdrawn from the endosperm when germination takes place. Glabrous, divaricate or sometimes pendulous shrubs, with moderately large, shining, reticulate leaves. Union fusiform, with numerous reddish-brown adventitious roots, the disc of which in the early stage, is thin and oblong-ovate in outline.

36. LORANTHUS DICTYOPHLEBUS F. v. M. Plate vi.

Rept. Burdk. Exped., 1860, 14; Benth., *B. Fl.* iii, 1866, 391; Moore and Betche, *Handb. Fl. N.S.W.* 1893, 228; Van Tiegh., *Bull. Soc. bot. Fr.* xli, 1894, 261, as *Amylotheca dictyophleba;* Engler et Prantl, *Pflzfam.*, Nachtr. iii, 1897, 126; Bail., *Bot. Bull.* xvi, 1903, as *L. tenuifolius*, changed to *L. Beauverdianus* Bail., *Com. Cat. Qland Plants*, 465, fig. 449; Bail., *Qland Fl.* Part v, 1902, 1378.

Glabrous; leaves opposite, ovate, oblong or ovate-lanceolate, narrowed into a short petiole, strongly penninerved and netveined, shining above, paler beneath; secondary peduncles few, lateral, usually three-flowered, forming a cymose corymb; lateral flowers short pedicelled; calyx obconical-cylindrical, with a repand margin, three or four times longer than the orbicular bracteole; petals 6, vitellinous, connate into a club-shaped-cylindrical, unilaterally somewhat dehiscent tube; limb in aestivation much narrower than the tube; anthers narrow-linear, basifixed; style capillary; stigma minute, capitate.

Supplementary Notes.

Compact, glabrous shrubs, 2-3 feet in diameter; attachment supported by numerous strong adventitious roots. Branches divaricate, erect, rarely pendulous, the older ones covered with a spongy or corky bark; lenticels minute or totally obscure. Leaves usually dark green, shining above, the veins conspicuous, paler and obscurely veined beneath, broadly elliptical to broadly lanceolate, a few narrow-lanceolate, 7-12 cm. long, tapering into a short petiole. Inflorescence glabrous in all its parts. Peduncles axillary, 1½-2½ cm. long, bearing 3-7 umbellate-divaricate branches, the flowers sometimes single on the short pedicels, but

[1] Since recorded as var. *spathulata*, Ewart and Tovey, *Proc. Roy. Soc. Vic.* xxxii (New Series), 1920, 199.

usually arranged in triads, the central flower of each triad sessile. Flowers somewhat striate, crimson, tipped with green, 4¼ cm. long. Bracts slightly decurrent, narrow-lanceolate, acute, concave, the apex much paler than the base. Calyx obconical, faintly sulcate when dry, the limb truncate, about 1 mm. broad. Buds acute, contracted about 7 mm. below the apex, inflated below the base of the petals. Corolla semitransparent, showing the curvature of the style in the inflated portion. Petals 6, all equal in length, deflexed, narrow-linear, acuminate, 7 mm. long. Filaments shorter than the anthers, the latter somewhat sagittiform, the cells membranous, imbricate around the style after the petals become deflexed, finally separating and becoming contorted after anthesis. Style capillary, tough, resting on the conical apex of the ovary; stigma clavate, rather large. Fruit elliptical to globose, 10 mm. long, changing from buttercup-yellow to deep orange-red, and finally to purple-brown. Endocarp thin, opening apically; seed elliptical, 5-7 mm. long, slightly ridged or furrowed with 6 faint divisions; endosperm light green. Embryo nail-shaped; embryonic cotyledons acute, and apparently articulate on the terete, smooth hypocotyl. Suctoral disc surrounded by numerous rather long green papillae, saturated with copious viscin, and forming a little mop around the head of the hypocotyl. Hypocotyl not cleft; the cotyledons appear to withdraw from the endosperm on germination.

Synonyms.—*Loranthus tenuifolius* Bail., *L. Beauverdiana* Bail., *Amylotheca dictyophleba* (F. v. M.) Engler, *Elytranthe dictyophleba* (F. v. M.) Engler.

Mueller does not say where the type is from. In his Report on the Burdekin Expedition, where the species was first described, he quotes the following localities: Illawarra, Hastings River, Moreton Bay. The latter is probably the type locality, as he collected it there himself. Through the kindness of Professor Ewart, of Melbourne Herbarium, I was able to examine the Hastings River specimen, which is similar to other New South Wales and Queensland specimens.

Range.—This species does not show a great amount of variation, considering its extensive coastal range from Cape York to Kiama, N.S.W. Its range will no doubt be extended further south as the flora is more thoroughly worked.

Affinities.—Mueller (*Rept. Burdk. Exped.*) refers to *L. loniceroides* as having affinity with this species. He says: "The leaves resemble greatly those of *L. loniceroides*. The contracted apex of the alabaster and the inflorescence seem mainly to distinguish our plant." Amongst the Australian species it has no really close affinity; its nearest is *L. Exocarpi* Behr, var. *spatulata*, which approaches it in the colour of the flowers, and in the strongly veined leaves, but *L. dictyophlebus* has a totally different inflorescence, and it also shows marked inequality in its broader leaves, which are relatively more reticulate.

L. vitellinus F. v. M. has often been mistaken for this species, but there is great diversity between the characters of the two species, and therefore the affinity is a superficial one.

Hosts.—Moraceae: *Ficus* sp. Magnoliaceae: *Drimys dipetala* F. v. M. Anonaceae: *Eupomatia laurina* R. Br. Monimaceae: *Doryphora sassafras* Endl. Cunoniaceae: *Ceratopetalum apetalum* D. Don. Lauraceae: *Cryptocarya australis* Benth., *C. microneura* Meissn. Sapindaceae: *Cupaniopsis anacardioides* Radk. Myrtaceae: *Backhousia sciadophora* F. v. M., *Eugenia Smithii* Poir.

Ser. Eudendrophithoe Endl.

Endl., Gen., 1839, 802; Engler, Engl. et Prantl, *Pflzfam.*, Nachtr., 1897, 129.

Flowers in pairs, racemes, or in axillary clusters, glabrous or pubescent, 5-, rarely constantly 6-merous, subtended by a small pedicellate bract, which enlarges

somewhat as the fruit develops. Calyx cupular, truncate, or irregularly dentate. Corolla curved, and usually inflated in the middle; segments linear, lanceolate; the inermis filaments longer or shorter than the anthers. Anthers linear-lanceolate, basifixed. Fruit subglobose, ovate or urceolate. Leaves well developed, penninerved. Adventitious roots usually present on young plants. Union ball-like on smooth-barked trees, fusiform on trees with a persistent rough bark, and invariably supported by adventitious roots when parasitic on the latter.

37. Loranthus acacioides (A. Cunn.) Benth. Plate vii.

Benth., *B. Fl.* iii, 1866, 392.

Glabrous with slender branches. Leaves alternate, oblong or lanceolate, obtuse, narrowed into the petiole, rarely above 2 inches long, rather thin and often 3-nerved. Peduncles axillary, solitary or in pairs, short and slender, reflexed, each with two flowers, on short slender pedicels. Calyx-limb prominent, truncate or sinuate, toothed. Petals not quite one inch long, united to about ¾ of their length into a slightly dilated tube. Anthers adnate, narrow linear.

Supplementary Notes to the Description.

Flowers bright red or orange-red; buds 3 cm. long. Corolla very thin; the slightly raised adhering portion of the filaments gives it a striate appearance, and a resemblance to *L. vitellinus*. Petals sometimes faintly trinerved inside. Anthers yellowish, 3 mm. long, with membranous-like margins. Filaments bent at the base of the anthers. Style yellow, wavy in bud, or bent from one side of the corolla to the other, straightening out on maturity, and exceeding the anthers by 3-4 mm. Stigma reddish, small, conical. Fruit orange-red or scarlet, somewhat urceolate, 5-8 mm. long; cotyledons not seen.

Synonym.—Elytranthe acacioides (A. Cunn.) Engler.

The type is probably from the Northern Territory or from the north-west coast of Western Australia. Robert Heward, in his biographical sketch of the late Allan Cunningham (p. 30), includes it amongst the plants from York Sound, Capstain Island, and Montagu Island, collected by Allan Cunningham, August, 1820. These localities are south of the Cambridge Gulf.

Range.—Northern Territory: Victoria and Fitzmaurice Rivers. *Western Australia*: Durack River; Derby, West Kimberley (on *Adansonia Gregori, Acacia sericata, A. flavescens*); Goody Goody; Lennard River (on *Cochlospermum heteronemum*); Barker River, near Lower King Edward River.

Affinities.—Its nearest affinity is *L. Exocarpi*, from which it differs in the alternate, narrow to broad lanceolate, pale-coloured, thin leaves, and in the frailer and longer common peduncle, which supports 1-3 flowers. It also bears a strong resemblance to the small leaved forms of *L. vitellinus*, in the shape, colour, and venation, and, to some extent, in the shape of the fruit; but the ramifications of the inflorescence are totally different in *L. vitellinus*.

Hosts.—Leguminosae: *Acacia flavescens* A. Cunn., *A. sericata* A. Cunn. Bombaceae: *Adansonia Gregori* F. v. M. Bixaceae: *Cochlospermum heteronemum* F. v. M.

38. Loranthus homoplasticus, n. sp. Plate viii.

Frutex glaber ramis tenuibus glaucis compressis apud nodos latioribus lenticulis. Folia opposita glauca sessilia late-cordata amplexicaulia 2-5 × 2-4 cm. Racemi tenues rhachide 1½ cm. longi, 3-8 flores praebentes. Flores breviter

pedicellati flavo-pruinosi 3 cm. longi superiores ultra folia exstantes. Bracteae cordatae vel orbiculares concavae 1 mm. Gemmae robustae arcuatae 30 mm. Calyx cylindricus lamina truncata 3 mm. Corolla tubo striato, petalis 5 crassioribus deflexis margine interiore lacerato. Filamenta compressa, antheris brevioribus adnatis linearibus 4-5 mm. Stylus angularis 3 mm. longior antheris coronatis stigmate conico obtuso. Fructus glaucus urceolatus 10 mm. nondum maturus.

Glabrous shrubs, branches slender, glaucous, compressed and broader at the nodes; lenticels obscure; leaves glaucous, sessile, opposite, broadly cordate, amplexicaul, 2-5 × 2-4 cm.; venation reticulate, median nerve distinct beneath. Racemes slender, the rhachis 1½ cm. long, 3—8-flowered; flowers shortly pedicellate, pruinose, yellow, 3 cm. long, exceeding the small upper leaves, but usually enclosed in the larger leaves; bracts cordate to orbicular, concave, 1 mm. long; calyx cylindrical with a rather prominent, truncate limb, 3 mm. long; buds robust, arcuate, 30 mm. long, gibbose at the point of attachment of the filaments; corolla-tube striate, petals 5, rather thick, deflexed, linear-lanceolate, 7-8 mm. long, the inner margins bordered by a small, lacerated fringe; anthers adnate, linear, 4-5 mm. long, slightly shorter than the compressed filaments; style angular, exceeding the anthers by about 3 mm., crowned by a rather large, obtuse, conical stigma; fruit glaucous, urceolate, the limb conspicuous, 10 mm. long, but not seen in a ripe state.

Synonym.—L. longiflorus Desr., var. *amplexifolius* Benth., *B. Fl.* iii, 1866, 390, but not of De Candolle, nor Thwaites; Bail. *Synop. Qland Fl.* 1883, 450, as *L. longiflorus* Desr., var. *amplexifolius* Benth.

Bentham (*l. c.*) refers to this plant as follows: "Leaves sessile, orbicular cordate. The specimens are fragmentary and do not show whether this be a distinct var. or only a form of leaf assumed at a particular age, or on some branches only."

It seems to me that Bentham had doubts about it being the same as *L. amplexifolius* DC. (*Prod. Syst. Veg.* iv, 1830, 305; Wight and Arn. Prod. 384; Ic. Fig. 301) which Thwaites (*Enum. Cey. Pls.*, 134) reduced to a variety of *longiflorus* Desr.

L. homoplasticus appears to differ from *L. amplexifolius* DC. in the following characters: Glaucous throughout; leaves smaller; racemes axillary (not terminal), shorter, with fewer flowers; buds shorter and stouter; flowers yellow or reddish (not purple); filaments without barbs; stigma larger; fruit urceolate, glaucous.

The leaves of *L. homoplasticus* bear a striking resemblance to the leaves of *Eucalyptus pulverulenta, E. cordata, E. melanophloia,* and *E. Krauseana,* hence the specific name.

Range.—Queensland: Cooper's Creek; Banks of the Mackenzie, near its junction with Comet Creek; Irwinbank; Stannary Hills (Dr. T. L. Bancroft, the type); Gulf of Carpentaria. (A few of the leaves on this specimen are alternate.) *Northern Territory*: Arnheim's Land.

Affinities.—Its nearest affinity is *L. vitellinus* F. v. M.; the flowers are somewhat similar, but the leaves sharply separate them. To *L. Benthami,* it is allied in the leaves; the inflorescence is, however, very dissimilar, which places it in a different section. Amongst the exotic species *L. amplexifolius* DC. is its nearest affinity.

Host.—Eucalyptus alba Reinw.

39. LORANTHUS VITELLINUS F. v. M. Plate ix.

Rept. Burdk. Exped., 1860, 12; *B. Fl.* iii, 390, as *L. longiflorus;* Ettingsh. *Über die Blatts. der Lor.* Tab. xii, fig. 3, as *L. coriacea* A. Cunn.; Britt. *Ill. Cook's Voy.* iii, 86, fig. 274 (in part) as *L. longiflorus;* Bail., *Fl. Qland*, v, 1378.

The following is the original description: Leaves alternate or some opposite, petioled, ovate or lanceolate, or oblong-ovate, rarely oblong-lanceolate, glabrous, opaque, somewhat penninerved, almost veinless; peduncles bearing a few-flowered raceme, rarely 1-3 flowered, sometimes obliterated, as well as the pedicels; bracteoles and calyces subvelutinous or glabrous; bracteoles solitary, roundish-ovate, considerably shorter than the toothless or at least irregularly 5-toothed calyx; petals 5, glabrous, rarely tomentose, orange-yellow, coherent into a cylindrical, curved, unilateral fissured tube; limb in aestivation narrower than the tube; filaments glabrous, fulvous; anthers linear, basifixed; stigma small, capitellate; berry truncate, globose-ovate.

Branches pendulous, cylindrical. Leaves 1½-3 inches long, 4-16, rarely only 2, lines broad, tapering into a long or short petiole, rarely subsessile. Pedicels 1-4, rarely 6, lines long, clothed, as well as the bracteoles and calyces, with a brown or grey velvet. Calyx 2-3 lines long, with a conspicuous limb. Bracteoles about 1 line long, sometimes acute. Corolla 1-1¾ inch long, with an orange-coloured tube and a red limb, not distinctly gibbous, although curved and slightly dilated below the limb; one of the lobes usually deeply separated. Anthers yellow, 1-3 lines long. Style thinly angular-filiform, longer than the corolla. Berry 3-4 lines long.

It will be seen from the description that more than one species is involved and apparently it includes *L. odontocalyx*, which Mueller regarded as a variety of *L. vitellinus*, and which was raised to specific rank by Bentham, who gave Mueller credit for it (vide *B. Fl. l. c.*). At the same time he suppressed Mueller's *L. vitellinus* as being conspecific with *L. longiflorus* Desr., an Indian-Ceylon plant, which is distinct from the Australian plant.

Through the kindness of Mr. J. H. Maiden, I was able to obtain from the Curator, Calcutta Herbarium, specimens of the Indian and Ceylon plants. After a careful investigation of the specimens I found that they represented three well marked forms of *L. longiflorus* Desr., viz.: (1) Strictly glabrous; leaves opposite or alternate, broadly oval-oblong, or oblong-lanceolate, shortly petiolate; filaments barbed. (2) The same as (1), but the filaments not barbed. (3) Leaves the same as in (1); young shoots and inflorescence hoary-pubescent; filaments barbed. The first appears to be the typical *L. longiflorus* Desr. (vide Wight, *Fl. Ind. Ori.* vi, 384, fig. 302). It seems to be quite glabrous with broadish leaves.

The flowers vary from 1-2½ inches long, with barbed filaments (vide Wight's fig. 302, *l.c.*). None of the specimens of *L. vitellinus* agrees with the foregoing. There are, however, three forms of the species that I have examined in conjunction with the Indian-Ceylon forms of *L. longiflorus*, viz.:

(A). Strictly glabrous with narrow oblong, lanceolate-falcate leaves tapering at both ends and particularly into a long terete petiole. Flowers 5-15 in the raceme.

(B). Young shoots, buds and pedicels rufous-pubescent; pedicels short and stout. Flowers 5-20 in the raceme, or usually 7-15.

(C). Young shoots, buds and pedicels hoary-pubescent; pedicels slender, bracts rather large. Flowers 3-9 in the raceme = *L. odontocalyx* F. v. M.

The leaves of (B) and (C) appear to be more variable than those of (A), ranging from obovate, with short petioles, to narrow oblong, or narrow lanceolate

with long petioles. (A) is the nearest approach to the Indian form (2), which is without deflexed hairs to the filaments, but the Australian plant has smaller and narrower leaves, with long terete petioles. All the Indian-Ceylon specimens that I have seen have broad leaves with a remarkable, short, thick petiole. It will be noted that the Australian specimens of this series are the reverse; the flowers are also smaller, and the calyces sometimes deeply toothed; and the filaments are always longer than the anthers. Forms (B) and (C) are pubescent, and to some extent resemble the Indian form (3). The leaves, however, are not the same; they are thinner, larger and broader, also more sessile in (3), and the filaments are barbed, while the calyx is also more truncate.

It appears to me that Bentham, in reviewing the whole of the forms, was impressed with the great similarity existing between the Indian and Australian specimens, and I am inclined to believe that the pubescent forms led him to look upon the Australian plant as being conspecific with the Indian plant, when he suppressed *L. vitellinus* F. v. M.

His description of *L. longiflorus* in the Flora (*l. c.*) includes all its forms; these forms, omitting the var. *amplexifolius*, have alternate leaves. It is rarely that examples of opposite leaves are met with; they occur sometimes, and to a very limited extent on young shoots, but ultimately become alternate; occasionally opposite leaves appear at the junction of two or more branches in some specimens. Both, however, are isolated cases.

The filaments of all the Australian plants are free from barbs or deflexed hairs, and they are as long as, or longer, than the anthers.

Kurz (*Forest Flora British Burma*, ii, 321) refers to the style of *L. longiflorus* as being 5-sided. Keeble states that the style of the Ceylon *L. longiflorus* is bent from one side of the corolla to the other. In *L. vitellinus* the style is very slender, and more terete than angular, and is only slightly curved in bud, but not bent from one side of the corolla to the other, as is common in *L. acacioides* Cunn. I therefore agree with Mueller, that, notwithstanding the peculiar similarity of *L. vitellinus* F. v. M. to *L. longiflorus* Desr., it is nevertheless distinct, and I feel justified in excluding *L. longiflorus* Desr. from the Australian Loranthaceae, and in restoring *L. vitellinus* F. v. M. as a valid species.

As already indicated, *L. vitellinus* is a composite species, and in order to ascertain what Mueller meant by his species, it is necessary to examine the specimens labelled *L. vitellinus* by him. They are as follows:

(1) Victoria River, F. Mueller, Oct., 1855. The young shoots and calyces are hoary pubescent. (2) Glencoe Station, Port Darwin, Nicholas Holtze. This is almost identical with (1). (3) Arnheim's Land, N. Holtze, 1892. With the same characters as the preceding. (4) *L. vitellinus* Ferd. Mueller, var. *odontocalyx* F. Mueller, on *Grevillea chrysodendron*. Towards McAdam's Range and Providence Hill, F. Mueller, Oct., 1855, with the following note, probably in Bentham's handwriting: "This is a cymose inflorescence, not racemose as in *vitellinus*." (5) *L. vitellinus*, var. *odontocalyx*, Arnheim's Land, F. Mueller. The same as (4), both being hoary-pubescent, and fragmentary. These constitute the type of *L. vitellinus* F. v. M., var. *odontocalyx* F. v. M. (*L. odontocalyx* F. v. M. of Bentham *l. c.*). (6) Archer's Station, Dr. Leichhardt, Nov. 23rd, 1843. The leaves of this specimen are narrow to broadly lanceolate, 2-5 inches long; young shoots and inflorescence rusty-pubescent. (7) Clarence River, Beckler. It has the same characteristic indumentum as (6).

Numbers 1 to 5 are all forms of one species, and are all more or less covered with a hoary vestiture, particularly the young shoots and inflorescence. Numbers 4 and 5 of this series are fragmentary and depauperate forms of the same species. The leaves are smaller in 4 and 5, but they are undeveloped and can be easily matched with the half-developed leaves of the series. Numbers 4 and 5 constitute the type of *L. odontocalyx* F. v. M., and as 1, 2 and 3 are almost inseparable from them, they appear to belong to the imperfectly known *L. odontocalyx* F. v. M. It is common in the north of the continent, but does not appear to extend further southwards than Rockhampton, in Queensland.

Numbers 6 and 7 have a totally different vestiture, and they also differ in other characters, but in the colour of the vestiture alone they are sharply separated. This form is most common in the Port Jackson district, and extends to North Queensland. It is quite possible that Mueller first received it from a New South Wales locality. As already indicated, Mueller looked upon the hoary plant as a variety of *L. vitellinus*, and it is quite probable that the rufous-pubescent, and glabrous plants were regarded by him as *L. vitellinus*. The same view was evidently taken by Bentham, for, in his description of *L. odontocalyx* he particularly mentioned the hoary vestiture of the plant. As the hoary-pubescent plant appears to find its natural position under *L. odontocalyx*, therefore, the rufous-pubescent plant represented by Nos. 6 and 7 can, without doubt, be looked upon as constituting *L. vitellinus* F. v. M.

Additional Notes to the Description.

Small glaucous shrubs with short, divaricate or pendulous, glabrous branches; the nascent parts and inflorescence infested with a minute, rufous or ferruginous tomentum; lenticels numerous, usually orbicular; attachment or union, an irregular fusiform swelling, though somewhat ball-like on smooth-barked trees; adventitious roots usually present, or occasionally absent when the union is ball-like, rarely longer than the branches; leaves narrow to broad lanceolate, occasionally ovate, thick and venulose, the veins more prominent on the upper surface; petioles usually short and thick, terete or compressed; racemes ¼-2 inches long, pedicels short, and considerably thicker than those of *L. odontocalyx*, densely rusty or rufous-pubescent, particularly when half-grown; buds rufous-pubescent, rather stout, acute, slightly angular at the top, the tube more terete, 1-1¼ inch long; corolla yolk-yellow shading to Indian-red; petals carthamnus-red shading to tomato-red; anthers narrow, lemon-yellow, 5 mm. long; filaments compressed and gradually narrowed upwards; style slightly bent in bud, exceeding the anthers by 1-2 mm., the upper portion reddish, or usually the same colour as the petals, terete throughout when fresh, but somewhat angular when dry; fruit oval-oblong to flask-shaped, 10-15 mm. long, 5-6 mm. in diameter, usually apricot-yellow at the base, shading into reddish-old-rose at the top; disc pentagonal; seed usually issuing from the base of the pericarp, oblong, 6-8 mm. long, resting upon a rather large, white, non-viscid, spongy base, from which arise 5 small, linear, acute appendages which project a little beyond the endosperm, giving the freshly released seed a dentate appearance; viscin copious, very sweet; endosperm green; embryo clavate, 4-5 mm. long; suctoral disc domed, quite smooth, about 2½ mm. in diameter before germination takes place; cotyledons linear, acute.

Remarks.—The flowering period of *L. vitellinus* is from August to January. In the Sydney district it is seen at its best in November, and is then a favourite food-plant of many birds. The following were observed by me feeding upon the

nectar: Spinebill, *Acanthorhyncha tenuirostris;* Tawny-crowned Honey-eater, *Gliciphila melanops;* Sanguineous Honey-eater, *Myzomela sanguinolenta;* Singing honey-eater, *Ptilotis sonora;* White-bearded Honey-eater, *Meliornis novae-hollandiae;* and White-eye, *Zosterops coerulescens.*

In the Hornsby district *L. vitellinus* is very destructive to the young Blood-woods, *Eucalyptus corymbosa*; it attacks the young plants when only 3-6 feet high, and many young saplings are completely decrowned by the parasite, which continues to grow for several years after the green top of the host succumbs to the ravages of the Loranthus. The plants are very upright in habit and the branches strong and thick when attached to hosts that allow plenty of air and sunlight, but on hosts that are densely foliaged the branches are usually long and pendulous. It is common to see it growing from the topmost branch of the highest Bloodwoods or from *Eucalyptus eximia, E. haemastoma, E. micrantha,* and *Angophora lanceolata;* whilst on *Angophora intermedia* it forms dense drooping masses, in company with *Phrygilanthus eucalyptifolius.* In the settled districts where the native flora has been destroyed it has adapted itself to the exotic vegetation, and is more or less a pest in many large gardens and orchards around Sydney and suburbs.

F. M. Bailey (*Weeds and Suspected Poisonous Plants of Queensland,* 178, under *L. longiflorus* Desr.) suggests that it should be classed as a noxious weed.

Synonyms.—*L. coriacea* A. Cunn. MSS., *L. longiflorus* Benth., *non* Desr.

Range.—This species has a wide coastal range, extending from Genoa in Victoria to the Endeavour River in North Queensland, and is known from Goose Hill, near Ord River, in Western Australia.

Affinities.—*L. odontocalyx* F. v. M. is its nearest affinity, and it can be distinguished from this by the rufous-pubescent vestiture of the nascent parts, young buds and calyces, also in the less denticulate calyx-limb; the rhachis and pedicels are also considerably thicker when in fruit, and the fruit smaller than *L. odontocalyx. L. Loheri* Merr., from the Philippine Islands, is remarkably like the small-flowered forms of *L. vitellinus.* It is, however, more delicate in all its parts and more glabrous than the latter. *L. acacioides* A. Cunn., somewhat resembles *L. vitellinus* in the shape and colour of the buds; and the coarse-leaved forms of the former are apt to be confused with the latter when other botanical characters are absent.

Mueller states that "*L. vitellinus* approaches closely to *L. longiflorus* Desr., according to plate 302 of Wight's *Icones Plant. Ind. Orient,* and a specimen collected in Khasia by Drs. Hooker and Thomson; the leaves we find smaller, the flowers often shorter, with a limb before expansion gradually tapering to the apex, and thereby subulate-conical, rarely turgid, and the stamens are smooth."

Hosts.—Casuarineae: *Casuarina suberosa* Ott. and Diet., *C. torulosa* Ait. Salicineae: *Populus alba* L., *Salix Babylonica* L. Betulaceae: *Quercus pedunculata* L. Platanaceae: *Platanus orientalis* L. Proteaceae: *Grevillea robusta* A. Cunn., *Hakea dactyloides* Cav., *Persoonia linearis* R. Br. Loranthaceae: *Loranthus congener* Sieb., *L. ferruginiflorus* W. V. Fitz., *L. Miquelii* Lehm., *L. pendulus* Sieb., *Phrygilanthus celastroides* (Sieb.) Eichl., *P. eucalyptifolius* (Sieb.) Engler. Santalaceae: *Exocarpus cupressiformis* Labill. Rosaceae: *Cydonia vulgaris* L., *Pyrus malus* L. Leguminosae: *Acacia decurrens* Willd., var. *normalis* Benth., and var. *mollis* Benth., *A. armata* R. Br., *A. pauciglandulosa* F. v. M., *Cytisus proliferus* L. var. *palmensis* Christ. Rutaceae: *Citrus Limonum* L., *Geijera parviflora* Lindl. Meliaceae: *Melia Azedarach* L., *M. Candollea* Juss., *Cedrela toona*

Roxb., var. *australis* C. DC. Anacardiaceae: *Schinus molle* L. Sterculiaceae: *Brachychiton populneus* R. Br. Myrtaceae: *Eucalyptus acmenioides* Schau., *E. Baileyana* F. v. M., *E. calophylla* R. Br., *E. corymbosa* Sm., *E. eximia* Schau., *E. haemastoma* Sm., *E. micrantha* DC., *E. maculata* Hook., *E. maculosa* R. T. Baker, *E. notabilis* Maiden, *E. Nowraensis* Maiden, *E. robusta* Sm., *E. Shiressii* Maiden and Blakely, *E. umbra* R. T. Baker, *E. viminalis* Labill., *E. obtusiflora* DC., *E. paniculata* Sm., *E. piperita* Sm., *E. punctata* DC., *E. rubida* Deane and Maiden, *Angophora Bakeri* Hall, *A. cordifolia* Cav., *A. intermedia* DC., *A. lanceolata* Cav., *A. ochrophylla* R. T. Baker, *A. subvelutina* F. v. M., *Tristania laurina* R. Br., *T. neriifolia* R. Br., *T. suaveolens* Sm., *Callistemon lanceolatus* DC., *C. linearis* DC., *C. rigidus* R. Br., *C. viminalis* Cheel, *Leptospermum attenuatum* Sm., *L. flavescens* Sm., *L. floribundum* Salisb., *Melaleuca Leucadendron* L., var. *albida* Sieb., *M. nodosa* Sm., *M. genistifolia* Sm., *M. linearifolia* Sm., *M. styphelioides* Sm., *Kunzea corifolia* Reichb.

Var. GLABRESCENS, n. var. Plate x.

Omnino glaber. Rami plerumque penduli glabri nitentes vix lenticulares. Folia sub-glauca angusti-lanceolata falcata vel plerumque angusti-oblonga. Petiole longa 5-20 cm. longa. Racemi 2½-5 cm., 7-15 floribus glabris simillibus eis typicae. Calyx nonnumquam acriter denticulatus.

Glabrous in all its parts; branches usually pendulous, often smooth and shining, scarcely lenticulate; leaves somewhat glaucous, usually narrow-lanceolate, falcate to narrow-oblong, rarely broadly oblong, tapering into a terete, often long petiole, 2-8 inches long. Racemes 1-2 inches long, bearing 7-15 glabrous flowers, which scarcely differ from the typical form; calyx sometimes deeply toothed.

Range.—It will be seen that this variety appears to have originated in the north of the continent and gradually spread southwards as far as Narrabri. *New South Wales*: Moema State Forest, Narrabri (on *Eremocitrus glauca* and *Acacia* sp. The union is similar to the typical form showing adventitious roots with caterpillar-like haustoria beneath them); Inverell (on *Magnolia grandiflora*); Terry Hie-Hie; Moree; Warrah; Liverpool Plains (on *Brachychiton populneus*); Wallangarra (on *Angophora* sp.). *Queensland*: Mt. Perry; Eidsvold (on *Eucalyptus melanophloia*); Knockbreak Station (on *Euc. crebra, Schinus molle*); Rockhampton (on *Euc. terminalis, E. alba*, J. H. Maiden, 3, 1909, the type); Port Mackay (on *Melaleuca Leucadendron* var. *saligna.*); Prairie, 30 miles east of Hughenden (on *Euc. microtheca*); Thirsty Sound (Banks and Solander, 1770, ex Herbario Musei Brittannica in part); Thursday Island. *Northern Territory*: Borroloola.

Hosts.—Magnoliaceae: *Magnolia grandiflora.* Rutaceae: *Eremocitrus glauca* Swingl. Leguminosae: *Acacia* sp. Sterculiaceae: *Brachychiton populneus* R. Br. Myrtaceae: *Euc. alba* Reinw., *E. crebra* F. v. M., *E. microtheca* F. v. M., *E. melanophloia* F. v. M., *E. terminalis* F. v. M., *Angophora* sp., *Melaleuca Leucadendron* L. var. *saligna* Bail.

40. LORANTHUS ODONTOCALYX F. Muell. (Herb.). Plate xi.

Benth., *B. Fl.* iii, 391; Bail. *Qland Fl.* v, 1379.

Glabrous, except the inflorescence, or slightly hoary-tomentose. Leaves mostly alternate, oblong, cuneate-oblong or lanceolate, obtuse, narrowed into a short petiole, under 3 inches long, thick and scarcely veined. Cymes axillary, sessile or very shortly pedunculate, usually 3- to 7-flowered, the short branches and pedicels

hoary-tomentose as well as the buds. Calyx tomentose, the limb more prominent than in the allied species, nearly as long as the adnate tube, 5-toothed. Petals 5, not quite 1 inch long, united to above the middle. Anthers adnate linear. Young fruits crowned by a long neck formed by the calyx-limb.

Professor Ewart, of Melbourne Herbarium, kindly donated to the National Herbarium, Sydney, portion of the type, and he afterwards submitted the remainder, and a specimen from Arnheim's Land, for investigation. The type is rather fragmentary and consists of a few small branchlets, loose leaves, buds, and an imperfect raceme. The branchlets are somewhat rough, partly owing to numerous minute lenticels. Leaves opposite and alternate, narrow lanceolate, dull or glaucous-looking, penninerved, 1½ to 3 inches long. Buds slender, hoary pubescent, curved, 20 mm. long, but not fully developed. Pedicels slender, about the length of the calyx, hoary, as well as the rather deeply toothed calyx. Bracts hoary, broad, acute, embracing the base of the calyx.

The type is without a doubt a depauperate specimen, and owing to the impoverishment of the plant, the inflorescence is greatly reduced; in fact, it is immature. The specimen from Howick Group, F. Mueller, quoted by Bentham under this species, has the cymose inflorescence peculiar to *L. pendulus* and its allies, which agrees with *L. Betchei*. Although Bentham regards this specimen with some doubt as belonging to *L. odontocalyx*, its general appearance probably led him to place it with *L. odontocalyx*.

Professor W. Baldwin Spencer collected a well grown specimen near Darwin, Northern Territory, 1911-12, which at first impressed me as being a rather long pedicellate form, but when compared with the type, especially the young shoots and undeveloped buds and calyces, I was convinced that it represented a more normal example of what the species might attain to, and that the material used in the original description was immature and imperfect.

The following is a description of Professor W. Baldwin Spencer's specimen, which is undoubtedly this species: Branches long and slender, the young one hoary-lepidote, lenticulate; lenticels orbicular, rufous; leaves oblong, obtuse, or oblong-lanceolate, 1½-4 inches long, ¼ to 1 inch broad, the median nerve and petiole reddish-brown, lateral veins numerous, arising at an angle of about 45°; racemes in pairs, shorter than the leaves, 3—7-flowered, with sometimes a solitary pedicellate flower at the base of the raceme, but quite free from it; flowers on slender pedicels 6-8 mm. long; bracts broad, cordate, acute, at first hoary, eventually becoming quite glabrous and sometimes greenish as they mature, slightly larger than those of *L. vitellinus*; calyx 4.5 mm. long in the newly expanded flower, cylindrical, and densely hoary-pubescent, denticulate or irregularly 5—6-toothed; young buds hoary, yellowish when mature, slightly curved, inflated for about ¾ of their length into a dilated tube, the upper portion more slender and uniformly terete, ending in a rather acute point. Corolla yellowish, cleft, to a little below the base of the free portion of the filaments, into 5, rarely 6, narrow, linear, acute, deflexed segments, somewhat tomentose inside; filaments narrow, shorter than the anthers, the same colour as the corolla; anthers narrow-linear, adnate, 5-7 mm. long; style slender, faintly angular; stigma capitate, larger than in *L. vitellinus*. Fruit 10-18 mm. long, oblong-urceolate, hoary, except the persistent calyx limb.

The mode of attachment has not been stated by any of the collectors. Its cotyledons are also unknown.

The history of this species has been dealt with under *L. vitellinus*, together with some of the Northern Territory specimens, which I regard as being almost typical of the species.

Range.—Northern Territory: McAdam's Range and Providence Hill (on *Grevillea chrysodendron*, the type); Victoria River (on *Eucalyptus* sp.) Glencoe Station, Port Darwin; Arnheim's Land. *Queensland*: Islands of the Gulf of Carpentaria; Gilbert River; Cairns; Mitchell River (on *Acacia Bidwilli*).

Affinity.—It is closely allied to *L. vitellinus*, from which it is readily distinguished by the hoary vestiture of the young buds, and the more slender pedicels, the uniformly toothed calyx, and larger and more tomentose fruit.

Hosts.—Proteaceae: *Grevillea chrysodendron* R. Br. Leguminosae: *Acacia Bidwilli* Benth. Myrtaceae: *Eucalyptus* sp.

Var. PROPRIA Blakely.

Proc. Roy. Soc. Qland, xxxix, 1922, 28.

Vestimentum surculorum juvenilium atque inflorescèntiae minute rufo-cinereum. Folia macra plerumque late lanceolata, 5-10 cm. longa, 2-5 cm. lata, petiolata; petiolare 1-2 cm. longae.

Vestiture of the young shoots and inflorescence rufous-cinereous. Leaves thin, usually broadly lanceolate, 5-10 cm. long, 2-5 cm. broad, petiolate; petioles 1-2 cm. long.

Inflorescence and structure of the flower the same as in *L. odontocalyx*, but the calyx is often entire and sometimes split on one side. The corolla is also glabrous inside, a character which brings it nearer to *L. vitellinus*, but the vestiture and the slender pedicels, together with the thin leaves, and also in some cases fewer flowers in the raceme, point to it being a form of *L. odontocalyx*. It is best described as being intermediate between *L. odontocalyx* and *L. vitellinus*, as it possesses some of the characters of each. The typical *L. odontocalyx* has a hoary vestiture, whilst that of *L. vitellinus* is ferruginous, and the vestiture of var. *propria* is partly both. It was first described from specimens from Yule Island, Papua (C. T. White, No. 736, July-August, 1918). The Australian plant does not appear to differ in any way from the Papuan plant.

Range.—Dunk Island; Kuranda (Leaves not unlike those of *Ligustrum lucidum*, shining above, pale beneath.); Cairns; Innisfail.

Ser. BENTHAMINA Engl.

Engl. et Prantl, *Pflzfam.* Nachtr. ii, iv, 1897, 132; genus *Benthamina* Van Tiegh., *Bull. Soc. bot. France*, xlii, 1895, 246.

Flowers binate, ferruginous, on short ferruginous, bracteate pedicels, rarely longer than the calyx. Buds straight or arcuate, clavate, inflated in the middle, contracted at the base. Corolla cleft to a little below the middle, but sometimes nearly to the base on one-side only. Petals very short, rather broad, spreading or deflexed. Filaments and anthers about the same length. Style very slender; stigma not large. Fruit urceolate, ferruginous. Compact shrubs, with closely matted adventitious roots. Branches short, divaricate. Leaves obovate to elliptical, with a spreading, somewhat obscure, venation.

41. LORANTHUS ALYXIFOLIUS F. v. M. Plate xii.

Rept. Burdk. Exped., 1860, 13, as *L. maytenifolius;* Benth., *B. Fl.* iii, 1866, 391; Van Tiegh., *Bull. Soc. bot. France*, xlii, 1895, 246; Engler, Engl. et Prantl, *Pflzfam.* Nachtr. ii, iv, 1897, 132; Bail., *Qland Fl.* v, 1902, 1379.

Leaves opposite, broad or orbicular-ovate, tapering into a very short petiole, faintly or indistinctly nerved and veined, very shining above; peduncles solitary

or geminate, usually 2—3-flowered, as well as the pedicels very short or obliterated, and together with the bracteoles and calyces thinly covered with brown-velvet down; calyx twice as long as the roundish bracteole; its limb minutely denticulated; petals 5, red, coherent into a long, slender, unilaterally dehiscent tube; limb in aestivation broader than the tube and blunt; its lobes narrow-lanceolate, short, inside yellow, outside slightly velutinous; free part of the filaments short; anthers linear, basifixed; style capillar-filiform; stigma minute, capitellate; berry urceolate ovate. Branchlets terete, not unfrequently verticillate. Leaves 1-2 inches long, above dark green, beneath less shining, in age at the margin somewhat recurved. Flowers terminal and axillary, crowded into irregular whorls. Corolla about 1½ inches long, more or less curved, outside slightly silky-downy, especially its limb, lobes hardly 3 lines long. Anthers measuring 1-1½ lines in length. Style short exserted. Ripe fruit unknown.

The following is a more detailed description: Compact shrubs with closely matted adventitious roots, and short divaricate smooth branches, forming dense masses, 2-5 feet in diameter; lenticels conspicuous. Leaves coriaceous, smooth and shining above, often dull and rust-coloured beneath, petioles compressed. Flowers a brilliant scarlet, almost glabrous, in pairs, on short ferruginous pedicels, rarely longer than the calyx, or forming clusters of 3-6 in and around the axils of the leaves or nodes of the branches. Bracts rusty-tomentose as well as the calyx, ovate-cordate, concave, minutely ciliate, about 3 mm. long. Calyx cylindrical, 4 mm. long, the limb conspicuous and ciliate. Buds terete, slender, curved, slightly swollen in the middle, clavate. Corolla striate, cylindrical for about ¾ of its length, then inflated to a diameter greater than that of the base, 3-4 cm. long, separating to within 3-4 mm. of the calyx on the upper side only. Petals 5 or 6, narrow, spathulate, reflexed, somewhat gibbose on the back, the apex acute, incurved, 5 mm. long, exceeding the anthers by about 2 mm. Filaments sometimes shorter than the anthers, but usually about the same length. Anthers adnate, oblong-linear, reflexed with the petals. Style very slender, capillary, imperfectly 4-angled, flexuose in bud, and sometimes the bent central portion will be seen protruding through the cleft in the centre of the corolla before the petals separate; stigma minute, capitate; disc distinctly raised around the base of the style into a thickened ring. Fruit elliptical, oblong, 8 mm. long, but not seen ripe, crowned by the persistent calyx limb. Cotyledons unknown.

Synonym.—L. maytenifolius F. v. M., *non* Gray.

Mueller quotes several localities but does not state which specimen constitutes the type. There is a specimen in the Melbourne Herbarium labelled in Mueller's handwriting, from Brisbane, without collector's name or date. It is probably Hill's specimen. Mueller very often omitted the collector's name and date from his labels. The specimen referred to does not differ in any way from those collected from other Queensland localities; it is also similar to the New South Wales specimens.

Range.—This species is a strictly coastal one, and from its range, as we know it at present, it appears to be confined to a limited area, extending from Moreton Bay in Queensland to the Hastings River in New South Wales.

Affinities.—Its nearest affinity is with *L. dictyophlebus*, from which it is distinguished by the smaller and less reticulate leaves, and in the rusty tomentose flowers.

In the leaves it is almost inseparable from *L. Whiteii*, but the connate petals are very dissimilar from the free petals of *L. Whiteii;* the buds of the latter are also more robust and clavate.

When not in flower, one is struck with the marked similarity of *Phrygilanthus celastroides* to this species, and the leaves of the former could very easily be mistaken for those of *L. alyxifolius*.

Hosts.—Salicaceae: *Salix babylonica* L. Moraceae: *Ficus* sp. Casuarineae: *Casuarina suberosa* Ott. and Diet. Monimaceae: *Daphnandra micrantha* Benth. Sapindaceae: *Guioa semiglauca* Radk.

Doubtful Species.

Van Tieghem (*Bull. Soc. bot. France*, xlii, 1895, 83), recorded the following species for Australia: *Loranthus tenuifolius* Van Tiegh. (*non* Engler, *non* Bailey), *L. Muellerianus* Van Tiegh., *L. Muelleri* Van Tiegh., *L. Leschenaultii* Van Tiegh., *L. Kingianus* Van Tiegh. (*non* Engler), *L. brevipes* Van Tiegh., *L. vittatus* (R. Br.), *ex* Van Tiegh. (*non* Engler).

I have endeavoured to procure a copy of the above publication but without success. I also applied to Professor Le Comte, Professor of Botany, Muséum D'Histoire Naturelle Botanique Phanérogamie, Paris, through Mr. Maiden, for the loan of Van Tieghem's types, and also for a copy of the descriptions of his species quoted above. Professor Le Comte replied that Van Tieghem had no types and that he did not leave a description of any of the species on record, so far as he was aware. It appears that Van Tieghem published the names only of his new species under his new classification.

As I have not had the facilities for thoroughly investigating the above species, I very reluctantly place them aside as doubtful species, but I shall be glad to receive information concerning them from any source.

Loranthus maytenifolius A. Gray, *Bot. Wilk. Exp. Exped.* i, 1854, 739, t. 99. This species has not been discovered since, and in order to form a better idea of it I made a requisition for the loan of the type through Mr. Maiden, and received from the Gray Herbarium, Harvard University, a drawing of some fragments made by Mr. Schuyler Mathews. The only flowering fragment depicted, in my opinion, does not agree with the plate of *L. maytenifolius*, but it is suggestive of *L. alyxifolius* F. v. M. The buds depicted in the drawing are very slender. In fact, they are uniformly slender and resemble those of *L. alyxifolius* very closely, much more so than the buds of *L. maytenifolius* as figured at t. 99 by Gray. The sketch showing the anthers in the insert accompanying the drawing belongs to a free petalled species, and this removes it from *L. alyxifolius*. It would appear that mixed material was used in the determination of this species, and the author was unaware of the fact. I have not the least doubt that the plant figured (t. 99) is the same as *L. celastroides* Sieber, *Phrygilanthus celastroides* Eichl, and the anthers depicted belong to an island species, probably *L. insularum* A. Gray, or to a closely allied species.

An examination of the plates of *L. maytenifolius*, *L. celastroides*, and *L. insularum* will at once show the close similarity between the three species. The line of demarcation between them is the versatile anthers of *L. celastroides*, the terminal inflorescence and adnate anthers of *L. maytenifolius*, in contradistinction to the axillary inflorescence of *L. insularum*. In many specimens of *L. celastroides* the inflorescence is terminal. It is very singular that several Australian botanical workers, quite independently referred specimens of *L. celastroides* to *L. maytenifolius*.

EXPLANATION OF PLATES I-XII.

Plate i.

32. *L. Murrayi* F. v. M. et Tate.

1. Flowering branch, nat. size. 2. Bud, enlarged. 3. Flower, enlarged. 4. Anther, enlarged. 5. Pedicellate bract, showing the narrow wings. 6. Fruit, nat. size.

Plate ii.

33. *L. Mitchellianus* (Hook.) Blakely.

1. Flowering branch, nat. size. 2. Flower, enlarged. 3. Style with young fruiting calyx attached, enlarged. 4. Fruit with style attached, nat. size. 5. Longitudinal section of fruit.

Plate iii.

34. *L. Casuarinae* Miq.

1. Flowering branch, nat. size. 2. Bud, enlarged. 3. Flower, enlarged. 4. Base of leaf, enlarged.

Plate iv.

35. *L. Exocarpi* Behr.

1. Flowering branch, nat. size (W. Gill, No. 697). 2. Flower. 3. Anther, enlarged. 4. Fruit, nat. size. 5. Seed, nat. size. 6. Germinating seed, nat. size. 7. Seed with two radicles, nat. size. 8. Seedling plant (after Brittlebank). 9. Longitudinal section of seed and 10. cross-section of seed (both after Brittlebank). 11. Natural position of a seedling plant three months old.

Plate v.

35*a*. A. *L. Exocarpi* Behr, var. *tenuis*, n. var. Flowering branch, nat. size.

B. *L. Exocarpi* Behr, var. *flavescens* (Muell.) Miquel. Flowering branch, nat. size.

C. *L. Exocarpi* Behr, var. *venulosa*, n. var. Flowering branch, nat. size.

D. *L. Exocarpi* Behr, var. *spathulata*, n. var. 1. Fruit natural size, but the common peduncle and the elongated pedicel enlarged. 2. A small leaf, nat. size.

Plate vi.

36. *L. dictyophlebus* F. v. M.

1. Flowering branch, nat. size. 2. Bract, enlarged. 3. Bud, enlarged. 4. Flower, enlarged. 5. Bud showing the position of the style. 6. Calyx and apex of ovary. 7. Fruit, nat. size. 8. Germinating seed issuing apically from the epicarp, slightly enlarged. 9. Adventitious root and suctoral disc, nat. size.

Plate vii.

37. *L. acacioides* A. Cunn.

1. Flowering branch, nat. size. 2. Flower, enlarged. 3. Anther, enlarged. 4. A broad, thick leaf from Lennard River (W. V. Fitzgerald, No. 744).

Plate viii.

38. *L. homoplasticus*, n. sp.

1. Flowering branch, nat. size. 2. Flower opened out, enlarged. 3. Fruit, nat. size. 4. A reniform leaf. 5. Leaf of *Eucalyptus melanophloia* for comparison.

Plate ix.

39. *L. vitellinus* F. v. M.

1. Flowering branch, nat. size, with short broad leaves, the most common form. 2. Flowering branch with long narrow leaves, less common than (1). 3, 4. Buds, enlarged. 5. Flower, slightly enlarged. 6. Corolla opened out, enlarged. 7. Fruit, nat. size. 8. Fruit with seed issuing from the base of the epicarp. 9. Seed, nat. size. 10. Embryo, nat. size. 11. Embryo opened out, enlarged. 12. A germinating seed, nat. size. 13. A young seedling, nat. size.

Plate x.

A. 39*a*. *L. vitellinus* F. v. M., var. *glabrescens*, n. var.

1. Flowering branch, nat. size. 2. Bud detached, nat. size. 3. Types of calyx, enlarged. 4. Long leaf from Port Mackay, Amelia District, No. 2513.

B. 5. Portion of a young plant of *L. vitellinus* F. v. M. showing the first attachment and the adventitious roots, nat. size.

a. Host, *Eucalyptus corymbosa* Sm. *b*. First attachment. *c*. Adventitious root. *d*. Attachment of adventitious root. *e*. Shoot arising from adventitious root, attachment similar to first attachment.

Plate xi.

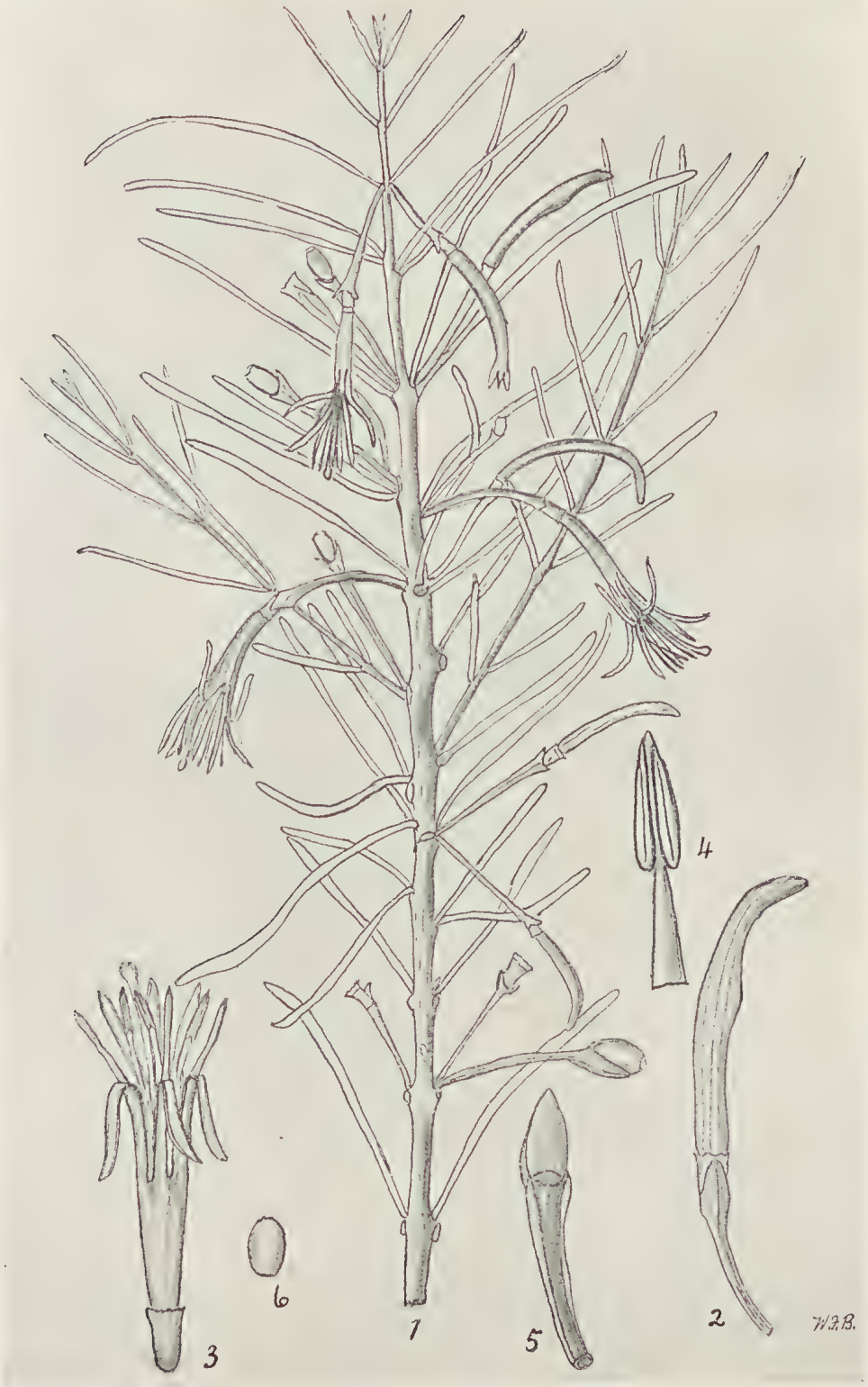
40. *L. odontocalyx* F. v. M.

1. Flowering branch, nat. size. 2, 3. Immature bud and leaf of type. 4, 5. Immature bud and leaf of G. F. Hill's No. 539. 6. Bud, enlarged. 7. Flower, enlarged. 8. Corolla opened out, enlarged. 9. Anther, front view, enlarged. 10. Anther, back view, enlarged. 11. Fruit, nat. size, but not fully mature.

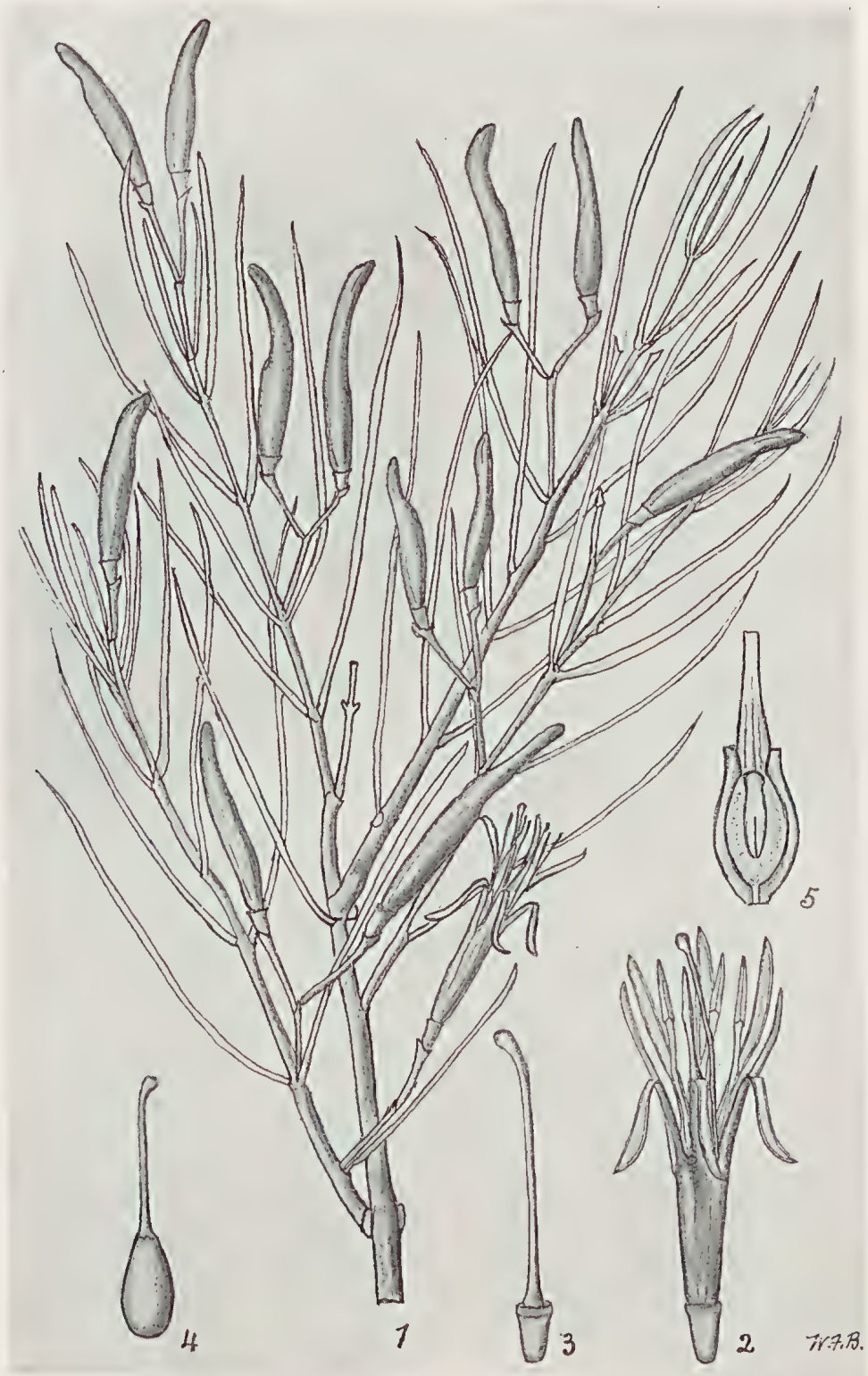
Plate xii.

41. *L. alyxifolius* F. v. M.

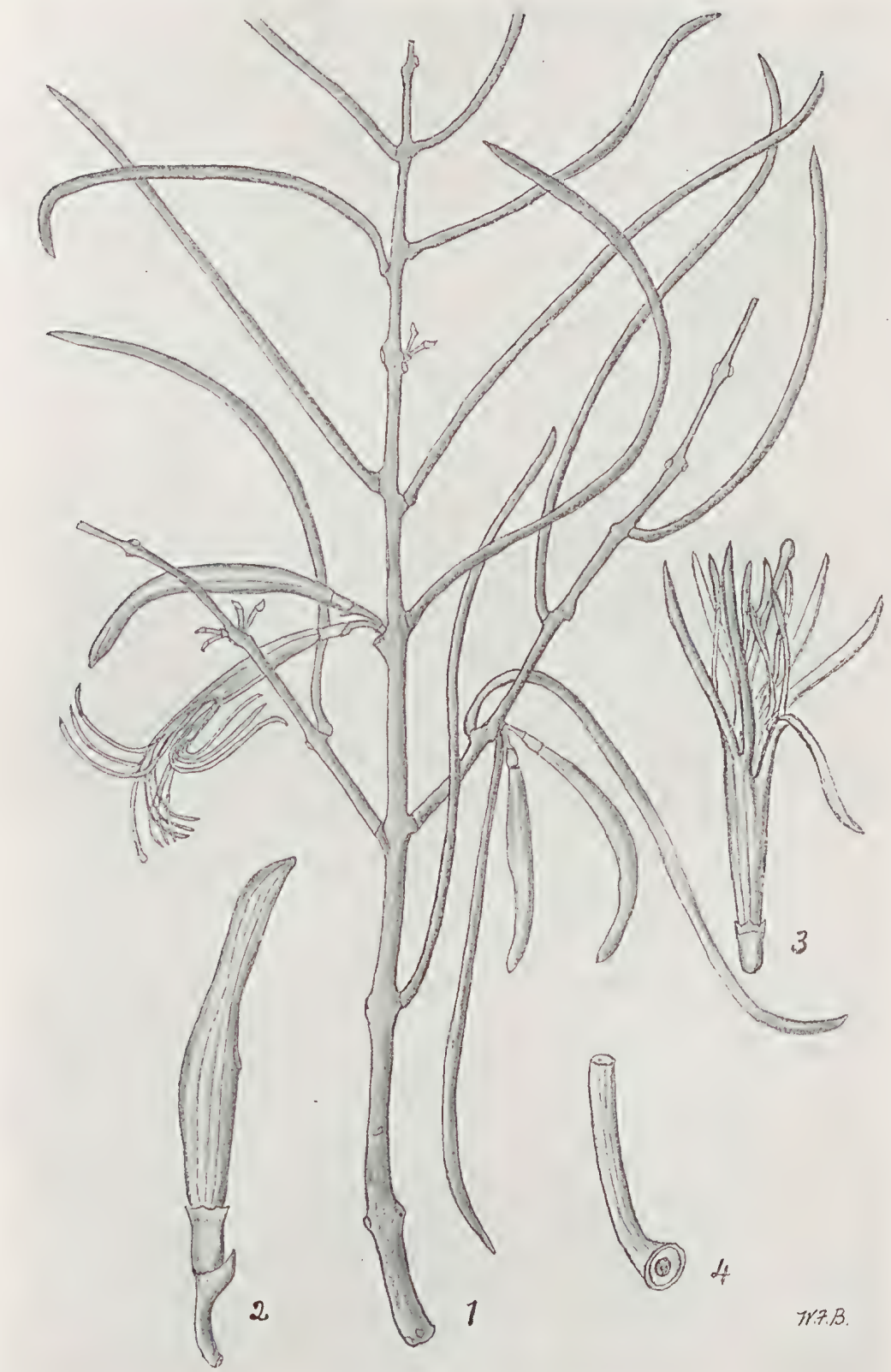
1. Flowering branch, nat. size. 2. Bud, enlarged. 3. Flower, enlarged. 4. A fruiting cymule, enlarged. 5. Fruit, nat. size.



32. *Loranthus Murrayi* F.v.M. et Tate.



33. *Loranthus Mitchellianus* (Hook.) Blakely.

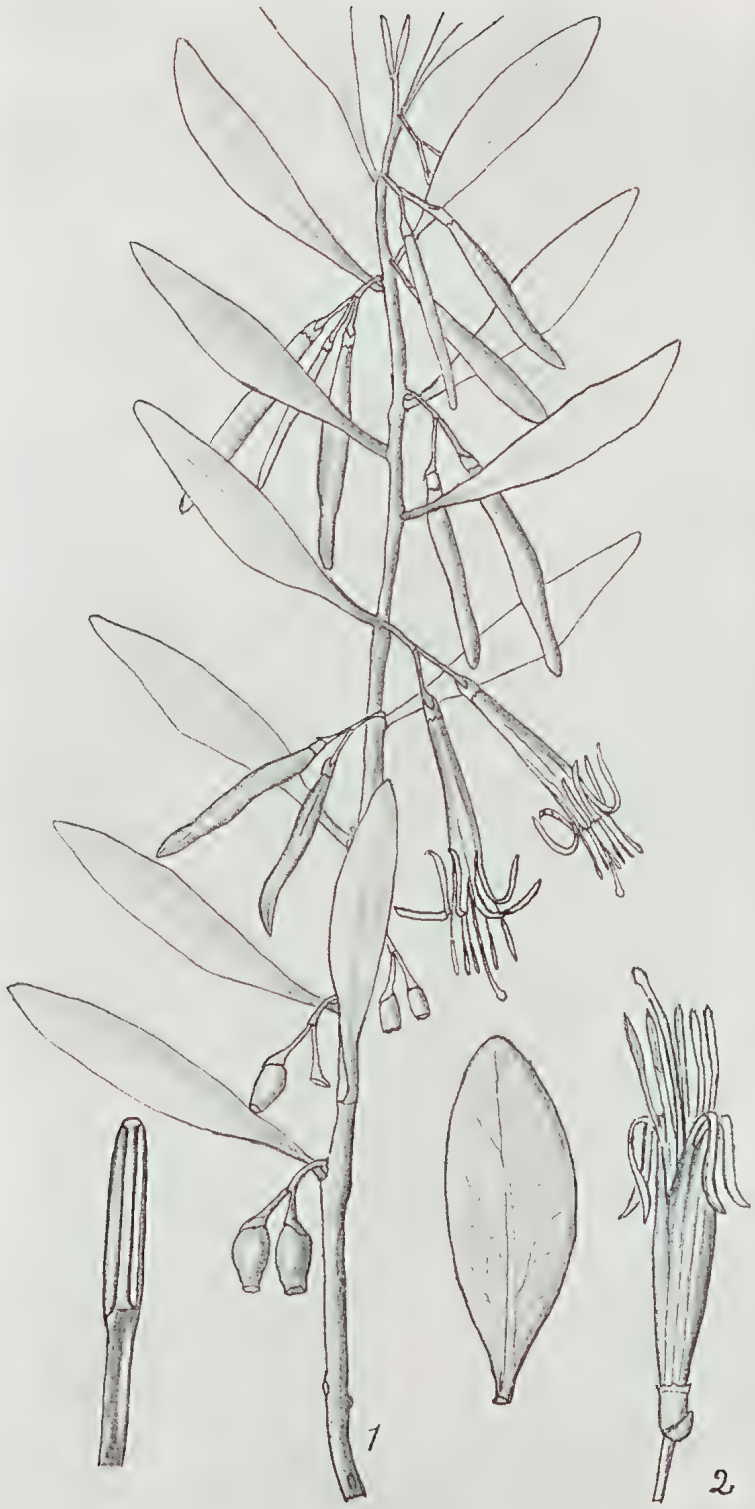


34. *Loranthus Casuarinae* Miq.

35. *Loranthus Exocarpi* Behr.

35a. *Loranthus Exocarpi* Behr.
A. var. *tenuis;* B. var. *flavescens;* C. var. *venulosa;* D. var. *spathulata.*

36. *Loranthus dictyophlebus* F.v.M.



37. *Loranthus acacioides* A. Cunn.

38. *Loranthus homoplasticus*, n. sp.

39. *Loranthus vitellinus* F.v.M.

39a. A. *Loranthus vitellinus* var. *glabrescens*, n. var.
B. Adventitious roots and mode of attachment of *L. vitellinus*.

40. *Loranthus odontocalyx* F.v.M.

41. *Loranthus alyxifolius* F.v.M.

NOTES ON THE OCCURRENCE OF GLENDONITES AND GLACIAL ERRATICS IN UPPER MARINE BEDS AT ULLADULLA, N.S.W.

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(Plates xiv-xv; and two Text-figures.)

[Read 25th March, 1925.]

Introduction.

The following notes have been prepared with the object of recording several interesting occurrences in Upper Marine Permo-Carboniferous rocks near Ulladulla, on the South Coast of New South Wales.

The features described occur on the sea-cut rock platforms developed along several miles of the coast; in common with similar features along the East-Australian coast, these platforms are exposed at low tide but are covered at high tide. The accompanying sketch map (Plate xiv) gives an indication of the geological structures on these platforms only.

Although faceted erratic pebbles have been known to occur in the sea-cut rock platforms near Ulladulla, as far as can be ascertained, no record has been made of the occurrence.

Previous Literature.

Evidence of glacial conditions in the Upper Marine Beds, near the mouth of the Shoalhaven River, was recorded by E. O. Thiele (*Proc. Roy. Soc. Vict.* xvi, Part 1, 1903, 57-59). No glendonites were mentioned, but it is now known that they occur at Crookhaven, near the mouth of the Shoalhaven River.

A complete bibliography of previous work on glendonites has been given by Professor David, Dr. Woolnough and Messrs. Taylor and Foxall (*Rec. Geol. Surv. N.S.W.* viii, 1905, 161-179), who definitely established the identity of "glendonite" as a pseudomorph after glauberite, and recorded four occurrences of Glendonites, all in Upper Marine Beds, three in the Hunter River District and one at Huskisson, Jervis Bay.

Later, Dr. A. B. Walkom (These Proceedings xxxviii, Part 1, 1913, 160) recorded all the known occurrences of Glendonite in Upper Marine (Permo-Carboniferous) Beds and described a new horizon in Lower Marine Beds at Harper's Hill in the Hunter River District.

It is considered that the glendonite beds about to be described are in a new locality, although not on a new horizon. Ulladulla is situated about 108 miles by sea from Sydney on the South Coast of New South Wales. The glendonites and erratics occur about 100 feet below the top of the Ulladulla Mudstones, which

underlie the Nowra Grits, and within 300-400 feet of the base of the Upper Marine Series in this area.

Ulladulla Mudstones.

The Ulladulla Mudstones probably do not exceed a few hundred feet in thickness at Ulladulla; they thin out completely a few miles to the south, and probably thin out more rapidly to the west. The overlying Nowra Grits rest unconformably on folded Devonian Slates at Yackengarrah Creek, about eight miles northwest of Ulladulla, and no trace of the Mudstones was found between this spot and the coast.

The mudstones are exposed along the coast for several miles north and south of Ulladulla Harbour. They are generally level-bedded or have a slight dip (up to 7°) to the east of north, but many local variations occur. In some cases these variations are due to the intrusion of basalt dykes probably of Tertiary age. More intensive folding and contortion occur in fossiliferous calcareous mudstones at Warden Head and North Head of Ulladulla Harbour. These contortions seem to have been contemporaneous with the formation of the beds, as they do not affect those beds immediately higher in the series.

Evidently associated with the folding, although of later date, faulting parallel to the axes of folding is indicated by four small reverse faults, showing underthrusting from the west. The faults have an average dip of 15° to the east with a throw of six to ten feet and a heave of twenty to thirty feet.

It is suggested that the strengthening of the strata by this compression has been a factor in the formation of both Warden Head and North Head: Warden Head runs out for over a mile from the general trend of the coast.

The mudstones are grey in colour and show fine laminations. In some places they are more or less calcareous, and they merge upwards into sandy beds. Spheroidal concretions about eight inches in diameter, embedded or partly embedded in the mudstones, form a striking feature on the rock platform, on both

Text-fig. 1.—Rock platform at Warden Head, Ulladulla, showing concretions exposed at low tide.

the north and south sides of Warden Head, as indicated on the accompanying map. They seem to be composed of material similar to the rock in which they occur and in some cases were found to contain a fragment of foreign rock or fossil in the centre.

Glendonites.

Glendonites were found over the areas indicated on the map (Plate xiv), the principal area being on the rock platform exposed at low tide, to the north of Warden Light House. At low tide the width of the platform is from 80 to 100 yards and the length over 500 yards. The beds dip at about 10° towards the foot of the cliffs in a direction W.15°S., thus the strike of the beds is nearly parallel to the trend of the neighbouring sea cliffs. Glendonites are exposed over the length of the platform (Plate xv, and Text-fig. 1), the base of the lowest horizon being about 75 yards from the base of the cliffs. Three beds with abundant glendonites occur along this platform, separated by thin beds particularly rich in fossils: the two lower glendonite beds merge into one another further north.

The following vertical section has been estimated for the rocks outcropping on this part of the platform.

Feet.	
25	Mudstones with numerous small erratics and some fossils.
6	Mudstones containing Glendonites.
1	Argillaceous limestone with *Cleobis* and *Pecten*.
7	Fossiliferous mudstone with Glendonites.
4½	Ferruginous mudstone with numerous erratic pebbles and abundant fossils (*Strophalosia*, *Spirifer*, Crinoids, *Fenestella*, etc.)
4½	Lower Glendonite horizon.
10	Mudstones with numerous erratic pebbles.

Overlying this series is another bed, containing glendonites associated with *Zaphrentis* and *Strophalosia*. It outcrops both on the north and south sides of Warden Head and seems to be separated from the lower complex glendonite horizon by a vertical thickness of about 30 feet of mudstones with erratics, but exact correlation was impossible on account of the many slight variations in dip.

On the platform round North Head there is another glendonite horizon, underlying a bed especially rich in *Strophalosia*. The strike here is approximately north and south, but, as a wide dyke fissure occurs immediately to the east, running in a northerly direction, this variation in the direction of strike is probably quite local. In all other respects, this occurrence corresponds with that of the Upper Glendonite bed at Warden Head to the south.

The glendonites occur as clumps of a dozen or more individuals, grouped together and embedded in the mudstone. The diameter of a group varies from three to six inches. Only two or three single crystals, each about six inches in length and an inch in thickness, were seen among hundreds of groups. An average of three clumps to the square yard occurs over most of the areas exposed.

In several cases the glendonites enclosed or partly enclosed *Zaphrentis*, *Strophalosia* or other shell fragments, in exactly the same fashion as was observed at Huskisson by Professor David, indicating the growth of the original glauberite (after which the glendonites are pseudomorphous) in soft muds containing the remains of marine organisms. The glendonites also cut through the bedding planes of the shales.

Chemical.—A few of the glendonites appeared to be composed of material similar to that at Huskisson, an analysis of which is given in the paper previously

mentioned. These were tested qualitatively and proved to consist of dark carbonate of calcium, almost entirely soluble in cold, dilute hydrochloric acid. No trace of barium or sulphates was found.

Most of the glendonites, however, consist of carbonate of iron, which, for a time, withstands weathering better than the surrounding shales. After a time the substance of the glendonites is attacked more rapidly and dissolved out, leaving hollow moulds. Not only the glendonites, but also the numerous fossils occurring with them, are completely replaced by carbonate of iron over a considerable area of the rock platform.

Crystallographic.—Crystallographically, the glendonites seem to be similar to those already described. No simple crystals which were suitable for measuring were observed, the majority of specimens consisting of complex groupings of a number of individuals, many of which show striated faces similar to that figured by Dr. Walkom (THESE PROCEEDINGS xxxviii, 1913, 167).

Petrographical.—Under the microscope, a section of a glendonite composed of calcium carbonate consists of three different types of calcite; the first type is brown in colour and shows a fibrous radiating structure, the second type has a yellowish colour and occurs as irregular grains, whilst the third type is quite clear and colourless and appears to fill in the spaces left in the calcite of the first type. The yellowish colour is due to traces of iron.

This is exactly similar to the calcite of the Huskisson glendonites, described by Mr. G. W. Card in the paper on the Jervis Bay occurrence.

The Erratics.

Erratic boulders occur in the rock platforms and adjacent cliffs over almost the whole of the area mapped, and are found in the beds containing very abundant fossils, in the glendonite beds and also in the overlying mudstones which are relatively barren of fossils. In size, they vary from a fraction of an inch in diameter to blocks over six feet in length: the large erratics occur in the mudstones stratigraphically above the glendonite beds. The erratics are mostly subangular, but many are well faceted. No undoubted striations were found on them.

They consist chiefly of granite, granite-gneiss, fine-grained schist, green slaty phyllite, black slates, quartz-porphyry, tuffs, quartzite, and milky quartz. The main types at Huskisson were described as "granite, mica-schist, aplite and quartz-porphyry."

The largest block was found embedded in the platform south of Coller's Beach (Plate xv). It measures seven feet by four feet six inches and is exposed to a depth of three feet. The longer axis in this case is running north and south. From its appearance it seems likely that less than half of it is exposed, so that its weight is probably of the order of 14 tons. It consists of grey granite-gneiss, medium to fine-grained, showing a distinct banding. In the hand-specimen, it appears to consist of quartz, white felspar and mica. The microscope reveals that the quartz "grains" have been shattered to a fine mosaic, accentuating the gneissic strucure; the felspar consists of orthoclase, microcline and plagioclase as irregular medium-sized grains, and the muscovite and biotite occur as more or less parallel wisps scattered through the rock. The biotite is partly decomposed but shows bending as evidence of strain. Assistant-Professor W. R. Browne has drawn my attention to the fact that a rock of this type has been described by Mahony and Taylor (Report on a Geological Reconnaissance of the Federal Territory, 1913, p.

54). It outcrops to the south of Canberra, on the western side of the Murrumbidgee River. A microsection of a specimen from Tharwa, in this region, shows a remarkable similarity in structure and mineral constitution to the erratic at Ulladulla, which is situated 70 miles due east of Tharwa.

This is perhaps the only rock type having any distinctive character, which might give an indication of the direction in which the ice moved its load of erratics.

Quartz porphyries and tuff are recorded as occurring in a belt to the east of the gneissose granites of the Murrumbidgee and small erratics of a quartz porphyry, with quartz and decomposing felspars in a devitrified groundmass, are very abundant in the mudstones near Ulladulla.

Pale green slaty phyllite exactly similar to rocks of Devonian age occurring to the west and south are found as erratics associated with quartzites and fragments of vein-quartz.

Several large erratics and numerous small pebbles are composed of a more or less weathered granite consisting of quartz, orthoclase and biotite. A somewhat finer-grained biotite-granite is known to occur about twelve miles away, but, as is the case with most of the other erratics, the type is rather common for definite correlation.

The longer axes of the large erratics point either from the west or from the south-west.

Summary and Conclusions.

The evidence, although not conclusive, seems to indicate that the great masses of ice, which were floating about in the sea during the formation of these Upper Marine beds, and continually dropping their loads into the soft muds forming on the sea floor, came from land situated to the west and south-west of the Ulladulla district.

The immediate effect of the cold conditions was to kill off large numbers of the organisms existing in the sea, resulting in the development of beds now exceptionally rich in marine fossils.

It is in the mudstones closely associated with these fossil beds that the glendonites occur, and they have not been found in the overlying mudstones, which do not contain abundant fossils, although continued cold conditions are indicated by the presence of numerous erratics. This may have some bearing on the conditions of the formation of the glendonites. Under inference number (x) of the summary of the paper by Professor David, Dr. Woolnough and Messrs. Taylor and Foxall, it is stated that "Possibly, suitable sulphate-forming bacteria may have existed in the black muds of the matrix." From the evidence available it seems possible that the sulphur necessary for the formation of the original glauberite, may have been derived from the decomposition of the soft parts of the abundant marine organisms, with or without the aid of bacterial action.

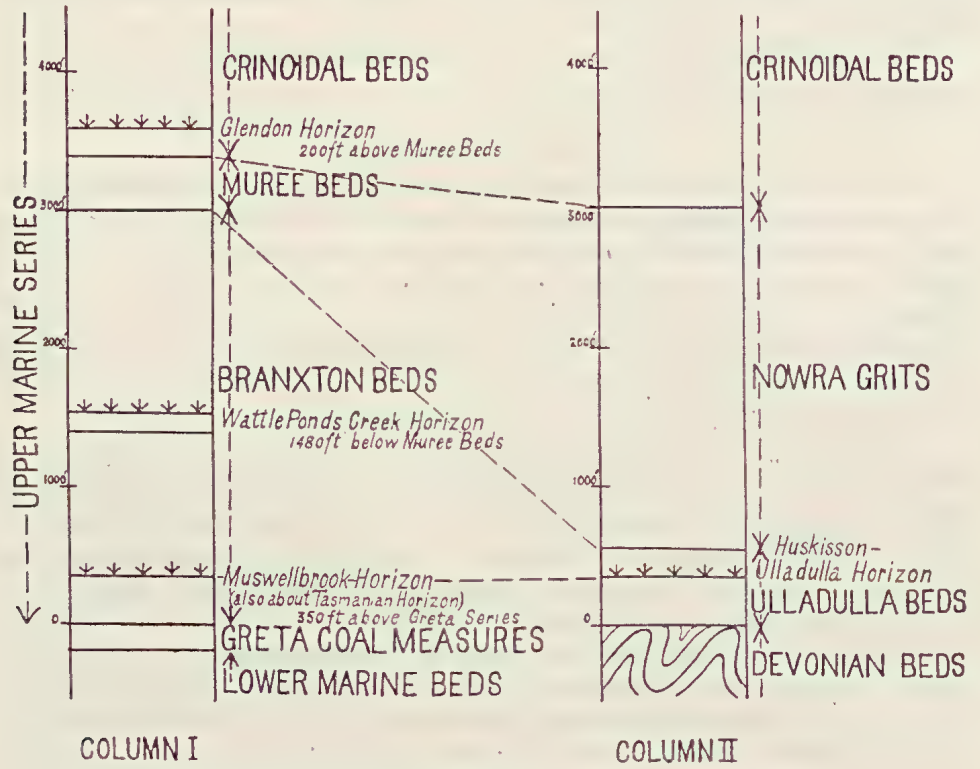
It is noteworthy that where glendonites occur in other localities, abundant fossils are frequently associated with them. This is true of the Lower Marine occurrence near Lochinvar, and the Upper Marine glendonites of the Hunter River District at Singleton.

It also holds good at Wollongong, Gerringong, Crookhaven and Huskisson as well as at Ulladulla. The fossils which are usually present consist of brachiopods, together with lamellibranchs, simple corals, crinoids and polyzoans. It is not known which, if any, of the microscopic forms, like Foraminifera, are present.

No information could be obtained as to the amount of sulphur that is likely to be available from this source, but the constant association of glendonites and marine fossils suggests some such causal connection.

The stratigraphical position of these glendonite beds, about 100-200 feet below the Nowra Grits, suggests that they may be correlated directly with the Huskisson beds to the north, and Mr. W. S. Dun, in conversation on the subject, said he considered from palaeontological evidence, that these horizons are identical.

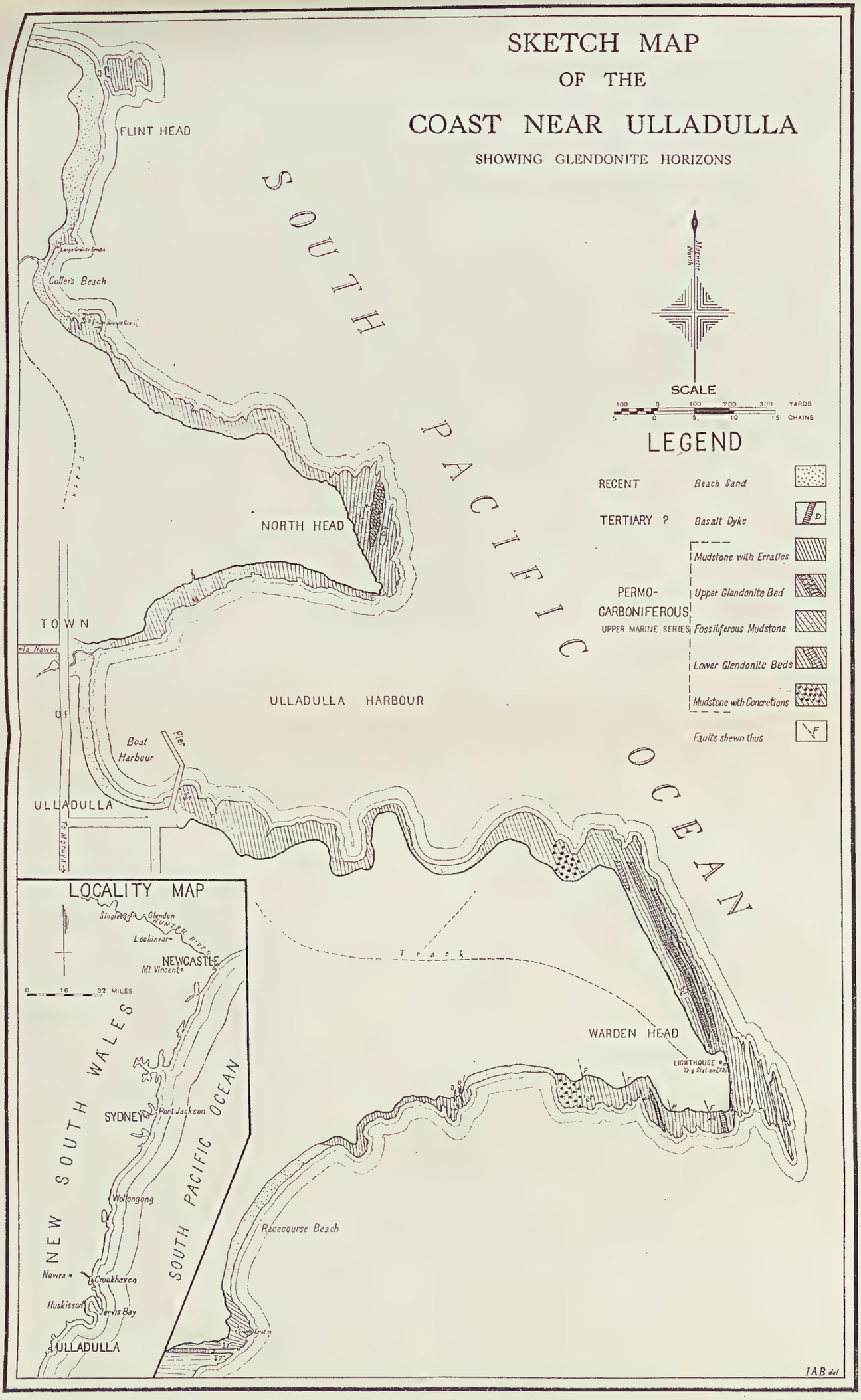
If the Nowra Grits are the equivalents of the Muree Beds of the Hunter River District, as first suggested by Professor David (*Ann. Rept. Dept. Mines, N.S.W.*, 1890, 250), then the Huskisson-Ulladulla horizon may certainly be represented as occurring 100-200 feet below these beds: but they are also within 300-400 feet of the base of the Upper Marine beds as developed in this area: thus it is possible that this horizon may be equivalent to the Muswellbrook and Tasmanian horizons, 350 feet above the Greta Series rather than forming a separate one higher in the Upper Marine Series, as indicated in the vertical section of the Permo-Carboniferous System given by Dr. A. B. Walkom, which is partly reproduced



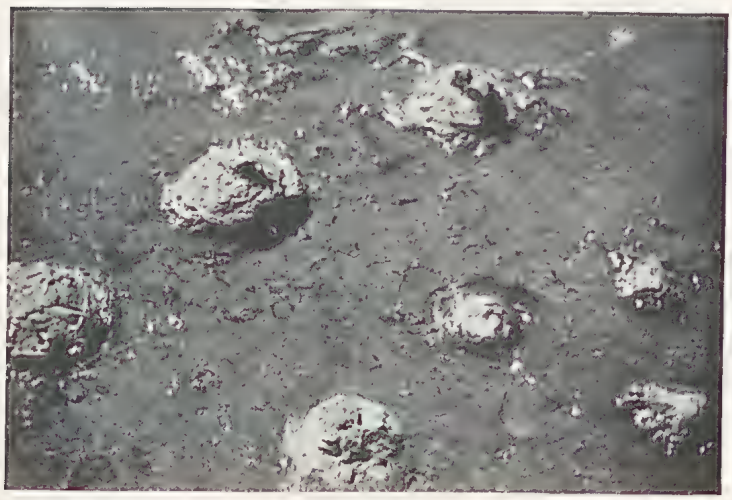
Text-fig. 2.—Vertical sections of parts of the Permo-Carboniferous System, showing suggested correlation of Glendonite horizons in the northern and southern coalfields.

in column i of text-figure 2. Column ii shows the equivalent stratigraphical succession in the South Coast District. Professor David, in his discussion of the Huskisson Beds, has correlated them with "the *Zaphrentis* horizon of the Branxton Beds (of the Hunter Coal-field) on the S.E. side of Black Creek. The latter

SKETCH MAP
OF THE
COAST NEAR ULLADULLA
SHOWING GLENDONITE HORIZONS



1



2

3

1. Group of glendonites. 2. Glendonites *in situ*. 3. Granite-gneiss erratic.

horizon is about 800 feet below the base of the Muree rock, and about 2,300 feet above the horizon of the Greta Coal Measures."

The position of the Wattle Ponds Creek horizon has been measured only with reference to the Muree rock, and may therefore also be equivalent to the Muswellbrook and Huskisson horizons.

The difficulty of correlating definite horizons is due to the unequal development of the marine beds in the Southern and Northern Coalfields.

The evidence in the Ulladulla District tends to confirm the inferences deduced in the paper by Professor David, Dr. Woolnough and others, with the exception of number (vi), which states that "The horizons of the glendonites being not far below, in some cases close to, the top of the highest beds of a Marine Series, where they are about to give place to fresh-water beds . . . ."

The Ulladulla Mudstones, in which the glendonites occur, are themselves the lowest beds of a marine series; the overlying level-bedded Nowra Grits are of the order of two thousand feet in thickness, and contain marine fossils at intervals right to the top of the series at Little Forest, a few miles north-west of Ulladulla at a height of 1,800 feet above sea-level, and almost that height stratigraphically over the glendonite beds.

In conclusion, the writer wishes to thank Assistant-Professor W. R. Browne for his advice on the preparation of this note.

EXPLANATION OF PLATES XIV-XV.

Plate xiv.

Sketch-map of the coast near Ulladulla, N.S.W., showing Glendonite horizons.

Plate xv.

1. Group of Glendonites from Warden Head near Ulladulla. Photo: H. G. Gooch.
2. Glendonites *in situ* on the rock platform at Warden Head, Ulladulla.
3. Large erratic of granite-gneiss embedded in rock platform at south end of Coller's Beach, near Ulladulla.

ON A REMARKABLE MODIFICATION OF THE EIGHTH ABDOMINAL SEGMENT IN *LINDERA TESSALATELLA*, WITH A DESCRIPTION OF THE MALE AND FEMALE GENITALIA.

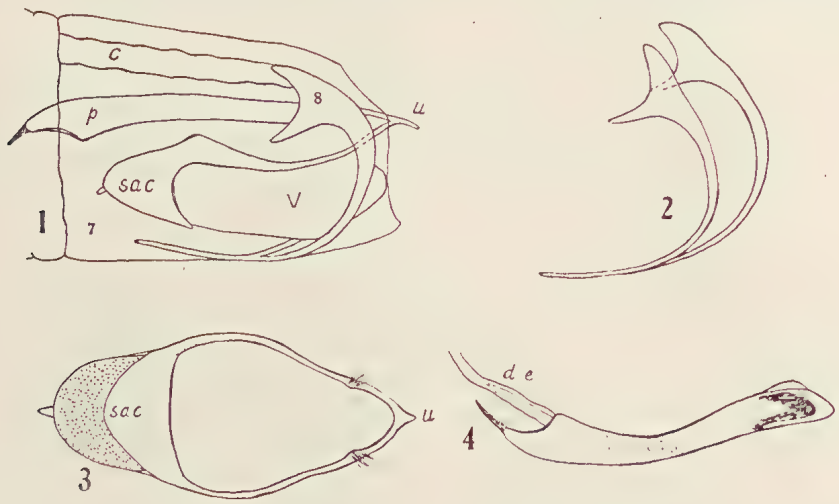
By Alfred Philpott, Assistant Entomologist, Cawthron Institute, Nelson, N.Z.
(*Communicated by Mr. E. C. Andrews.*)

(Nine Text-figures.)

[Read 25th March, 1925.]

The species under notice was described by Blanchard in 1852 (*Hist. fis. y pol. Chile*, Zool., vol. 7, p. 105). It is a well-known Australian species and is now established in New Zealand, at least in the North Island, and in Nelson in the South Island.

In the following paper it is proposed to give a description of the male and female genitalia, there being some features of special interest in these structures.



Text-figs. 1-4.—*Lindera tessalatella* Blanch.

1.—Lateral view of terminal segments of male, showing normal position of genitalia. *c*, colon; *p*, penis; *sac*, saccus; *u*, uncus; *v*, valva; 7, seventh segment; 8, modified eighth segment. 2.—Modified eighth segment, obliquely lateral view. 3.—Tegumen, from beneath. *sac*, saccus; *u*, uncus. 4.—Penis. *d.e.*, ductus ejaculatorius.

The Male Genitalia.

The abdomen, normally, shows only seven segments, the genitalia being withdrawn within the last one (Text-fig. 1). The ninth sternite forms a large saccus, the cavity of which receives the rounded basal part of the valvae; basally it bears a small finger-like projection. The saccus merges, without articulation, into the ninth tergite (forming the upper part of the tegumen), which is thin and hoop-like, a short slender uncus springing from its apex (Text-fig. 3, also Text-fig. 1).

The valvae.—The valvae (Text-fig. 5) are broad and rather concave, but much narrowed on the apical fourth. The upper part of the base is deeply excavate, leaving only a narrow portion of the costal margin projecting. The armature is feeble, consisting only of a series of short blunt spines round the edge of the narrow apical part, and a few weak hairs.

The penis.—The penis (Text-fig. 4) is a blunt, slightly-curved organ. The aedeagus is not strongly chitinised and bears no armature. Its base is curvedly truncate, forming a large aperture, into which the rather small *ductus ejaculatorius* enters.

The modified eighth segment.—Embracing the genitalia as they lie in their ordinary position is a strongly chitinised structure (Text-fig. 2, see also Text-fig. 1). It begins as a thin rod lying beneath the saccus, but, after passing under the valvae for a short distance, it divides into two branches which curve upwards, one on each side of these organs. Its upper portion is recurved, much broadened and divided apically into two prongs, the upper pair of which nearly meet dorsally. The valvae, tegumen and penis all lie within it and its function is evidently to act as a support for these structures, providing a strong, and at the same time elastic, control. It should also be noted that the lower prongs are so directed as to pass over the penis, thus giving additional protection.

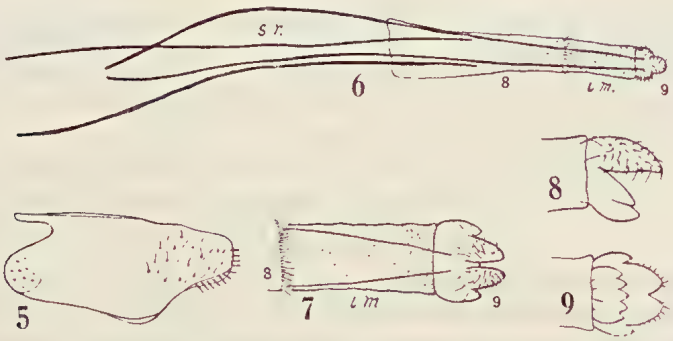
No such organ as the one here described had been previously met with by the writer in connection with the genitalia of the Lepidoptera. Though extremely puzzling at first sight as to origin and homology, it became a simple matter when it was recognised that here we had merely the eighth segment, or possibly the eighth sternite only, which had become modified into a spring-like band to support and protect the all-important terminal organs of the abdomen.

The Female Genitalia.

The copulatory opening, *ductus bursa*, and copulatory pouch offer no unusual features and need not be further referred to, but the ovipositor exhibits some interesting peculiarities. When in a position of rest the eighth and ninth segments, which form an elongated ovipositing tube, are in great part withdrawn within the abdomen. The ninth is telescoped within the eighth, except for the swollen apex, and the eighth is, in turn, retracted within the seventh, only the inter-segmental membrane protruding. A ring of bristles marks the apex of the eighth segment, and apparently acts as a guide for the correct degree of withdrawal. When fully exserted these two segments, with their connecting membrane, make up about two-fifths of the whole length of the abdomen.

The segmental rods (Text-fig. 6) are very long; in the normal position of the abdomen those of the ninth reach to just within the fourth segment, while those of the eighth extend almost to the third, their extremities being curved strongly upwards so as nearly to touch the dorsal wall of the segment.

The ninth segment terminates in a rosette-shaped opening which can best be understood by reference to the figures (Text-figs. 7, 8 and 9). The dorsal part of this rosette consists of an apically bifid lobe, bearing a number of curved hairs. The function of these hairs, which are curved backwards and outwards, is probably, by engaging with the material among which the eggs are being laid, to hold the end of the abdomen in the desired position. There is a small lateral piece and a fairly large ventral one, divided into five lobes.



Text-figs. 5-9.—*Lindera tessalatella* Blanch.

5.—Valva, from within. 6.—Terminal segments of abdomen of female. *8* eighth segment; *9*, ninth segment; *i.m.*, intersegmental membrane; *s.r.*, segmental rods. 7.—Dorsal view of "rosette." *8*, eighth segment; *9*, ninth segment; *i.m.*, intersegmental membrane. 8.—Lateral view of "rosette." 9.—Ventral view of "rosette."

Though the actual act of oviposition in *Lindera* does not appear to have been observed, it seems highly probable, judging from the structure of the ovipositing organ, that the eggs are laid in cracks or crevices, such as would be beyond the reach of a shorter structure. Mr. J. G. Myers has reared the moth from larvae found in old sacking and rubbish; doubtless the elongated organ would be suitable for the deposition of eggs in the interstices of such material.

NOTES ON AUSTRALIAN DIPTERA. No. v.

By J. R. Malloch.

(Communicated by Dr. E. W. Ferguson.)

[Read 29th April, 1925.]

In this paper I present keys for the recognition of the genera of Muscidae known to me from Australia. It is quite probable that there are some genera, and certain that there are many species, unknown to me, and I believe that the best method of interesting Australian students of Diptera in this rather difficult family is to make available to them data for the recognition of the known genera and species. From experience I judge that there is nothing tends more strongly to divert students from the intensive study of a group than a multiplicity of genera and species scattered throughout the literature of many countries, and in many languages, with no synoptic literature available for their recognition.

I do not presume to say that this attempt to elucidate the Australian genera is perfect, that anyone without experience in the work may sit down and in an off-hand manner name whatever species comes to hand. But the matter herein presented is the result of over twenty years' study of the group and contains data which, in some cases, are made known for the first time in print. I have had ready for the press for some years a key to the genera of Muscidae of the world, but have delayed publishing it, as I desire to make a more extended study of some difficult groups, more especially those occurring in New Zealand. It would serve no good purpose, even for comparison, were I to include in this paper genera not yet known from Australia, so I confine my presentation strictly to those genera I have seen from my various correspondents in Britain, Australia, and elsewhere.

Included in the family are all species that possess the following combination of characters: Second antennal segment with a longitudinal split at apex above, slightly to the outer side; spiracles of abdomen situated in the tergites at varying distances from the lateral margins, rarely in extreme margins; auxiliary vein of wing complete, ending in costa well in front of apex of first vein; postscutellum not convex; hypopleura without a vertical series of strong bristles below spiracle, sometimes with some fine hairs in this region; vibrissae present.

The nearest related families are the Calliphoridae and Tachinidae on the one hand and the Dryomyzidae, Helomyzidae, and Sciomyzidae on the other. The group usually referred to as Scatophagidae or Cordyluridae I consider a subfamily referable to Muscidae, but I have seen no species from Australia that belongs here, the only genus referred to it definitely by a recent author, *Tapeigaster* Macquart, being, I think, an acalyptrate.

Within the past two or three decades there has been considerable change in the opinions of workers on the calyptrates as to the limits as well as the number of families in this division. The more dogmatic definitions of these families have

been laid down by those workers who have confined their efforts to the species of a limited faunal region, and the increase in the number of families is credited to those who, covering several faunal regions, have endeavoured to apply the same differentiating characters to the entire assemblages as to the components of any given faunal region, with very unsatisfactory results. It appears to me, from a critical survey of a multitude of species from every part of the world, that we may be compelled to recognize but four families in this complex, Tachinidae, Calliphoridae, Oestridae, and Muscidae. There are several groups, such as are represented by the genera *Sarcophaga*, *Metopia*, *Rutilia*, *Aulacocephala*, and *Mesembrinella*, etc., which may serve as the nucleus of tribes or groups of lesser rank than families, even subfamilies, but, unless we are prepared to elevate the four groups above named to the rank of superfamilies, we must perforce admit that family rank, even for the most distinct of the others, is out of the question, viewing the matter from a comparative point of view.

I present below a key to the four families listed above.

Key to Families of Calyptrata.

1. Hypopleura without a vertical series of strong bristles below spiracle ..... MUSCIDAE (incl. GASTROPHILIDAE)
   Hypopleura with one or more vertical series of bristles below spiracle 2
2. Mouth parts vestigial ..... OESTRIDAE
   Mouth parts well developed, functional 3
3. Postscutellum not conspicuously convexly developed ..... CALLIPHORIDAE
   Postscutellum prominently convexly developed ..... TACHINIDAE

There does not appear to me to be any good reason, based upon structure, for the separation of Tachinidae from Dexiidae of authors. The absence or presence of hairs on the arista, the only character that is used generally for the separation of these groups, being unreliable for that purpose, I have included them both under Tachinidae in the above key.

I present below a key for the recognition of the subfamilies of Muscidae known to me from Australia.

Key to Subfamilies of Muscidae.

1. Sixth wing-vein complete, faint apically, but extending to margin of wing; thorax with but three strong pairs of postsutural dorsocentral bristles; hind tarsus with an outstanding bristle at base below on basal segment; eyes of males narrowly separated above, of females separated by about one-third of the head width, interfrontal stripe in this sex generally with a pair of cruciate bristles about the middle; hind tibia with at least two long posterodorsal bristles; scutellum with some erect soft hairs below apically ..... ANTHOMYIINAE
   Sixth wing-vein not distinctly traceable to margin of wing; other characters not as above *in toto* 2
2. Pteropleura with a group of hairs in centre; eyes of males and females separated by about one-third of the head width, the interfrontalia without cruciate bristles; palpi dilated apically, usually conspicuously so; parafacials with some hairs on their entire length ..... LISPINAE
   Pteropleura bare, or, if haired, the eyes of males are not as widely separated as those of females; in no case are the palpi conspicuously dilated, and the parafacials are bare below bases of antennae 3
3. Sixth wing-vein very short, the seventh more or less distinctly curved forward round its apex; hind coxae usually with one or two fine hairs at apex above; thorax with three pairs of postsutural dorsocentral bristles; each orbit in females and in males with wide frons with two bristles on upper half directed outward over eyes, or the upper one slightly backwardly directed ..... FANNIINAE

Sixth wing-vein sometimes very short, but when it is, the seventh is straight and never curved forward round its apex; hind coxae bare at apices above; orbits not with two upper bristles curved outward over eyes in either sex 4

4. Frons in both sexes one-third of the head width, each orbit with one long backwardly directed bristle on upper half; thorax with but one pair of presutural dorsocentral bristles; lower stigmatal bristle directed downward .... COENOSIINAE

Frons of male narrower than that of female, or, if equally wide, the orbits have each two backwardly-directed bristles on upper half; there are two pairs of presutural dorsocentrals present, or the lower stigmatal bristle is not directed downward .. 5

5. Proboscis heavily chitinised, fitted for piercing, the labellae not enlarged or spongy; arista with long hairs on upper side, bare or pubescent below; lower calyptra as in Phaoniinae; fourth wing-vein bent forward at or before middle of its apical section ..... STOMOXYDINAE

Proboscis not heavily chitinised, or fitted for piercing, the labellae generally large and more or less spongy, with chitinous rods or teeth; arista with the hairs almost invariably equally long above and below 6

6. Lower calyptra rounded apically, its inner basal margin well separated from the basal angles of scutellum; fourth wing-vein never angularly bent forward near middle of its apical section; if curved apically, the beginning of the curvature is generally well beyond middle of apical section ..... PHAONIINAE

Lower calyptra more or less transverse at apex, its inner basal margin close to or underlying the basal angle of scutellum; fourth wing-vein conspicuously bent forward at or close to middle of its apical section, sometimes angularly so ..... MUSCINAE

Subfamily ANTHOMYIINAE.

This subfamily I consider the most generalized of the family. It is essentially northern in its distribution, being abundantly represented in Europe and North America, extending its range into the Arctic Regions. Many of the species are phytophagous, some of them doing serious damage to root-crops and cereals. So far I have seen but three genera from Australia and these may be distinguished by means of the key presented below.

Key to genera.

1. Propleura haired in centre, i.e. below humeral angle and above propleural bristle in front of spiracle; species densely whitish-grey pruinescent, with conspicuous black spots on dorsum of thorax and abdomen ..... *Anthomyia* Meigen

Propleura bare in centre 2

2. Mid tibia without a ventral median bristle ..... *Hylemyia* R.-D.

Mid tibia with a distinct median ventral bristle ..... *Egle* R.-D.

Genus ANTHOMYIA Meigen.

I have seen but one species of this genus from Australia, *vicarians* Schiner. Stein considered this species to be a synonym of *illocata* Walker, but I think he was in error. I have published a key to the species of the genus known to me (*Annals and Magazine of Natural History*, 1923, 267). Unfortunately the last section of caption 16 referring to *vicarians* was accidentally omitted in printing the key. This should read:

"No dark spot at base of antennae in male; base of scutellum black .. *vicarians* Schiner"

The specimens I have seen are from Eccleston and Maroondah, N.S.W.

Genus HYLEMYIA R.-D.

I have recently published a key to the known Australian species of this genus.

Genus EGLE R.-D.

But one species of this genus is known to me from Australia. As it is of some economic importance, the larvae feeding in various root-crops, I give a short description of it to facilitate its identification.

An entirely black species, the interfrontalia of the female usually rufous in front; wings hyaline. Calyptrae white. Halteres yellow. Thorax in male with three broad black vittae, the spaces between them not conspicuously pale; in the female the thorax is much more densely gray pruinescent and the vittae are not very noticeable. Abdomen in male gray pruinescent, with a broad central vitta and a narrow apical and basal fascia on each tergite black.

Eyes very narrowly separated in male, in female separated by fully one-third of the head width, interfrontalia in female with a pair of cruciate bristles; arista pubescent. Thorax with 2 + 3 pairs of dorsocentral bristles and one or two pairs of presutural acrostichals. Abdomen in male depressed. Fore tibia with one anterodorsal and one posterior bristle near middle; mid tibia with one ventral, one anterodorsal, and two or three posterior bristles; hind femur in male with a series of long bristles on anteroventral and another on basal two-thirds of posteroventral surface; hind tibia with one or two anteroventral, four to six anterodorsal, and three posterodorsal bristles. First posterior cell of wing slightly narrowed apically. Lower calyptra protruded.

Length, 5-5.5 mm.

One pair, Melbourne, Victoria, 14th Nov., 1923.

Subfamily Lispinae.

I have already published a generic key to this subfamily (These Proceedings, xlviii, 1923, 606).

Subfamily Fanniinae.

There are but two genera of this subfamily known to me from Australia. I give a diagnosis below for their identification.

A. Eyes of male separated by less than one-fifth of the head width; entirely black species, or at most only the base of abdomen faintly translucent yellowish ..... *Fannia* R.-D.

AA. Eyes in both sexes separated by one-third of the head width; legs and abdomen tawny yellow ..... *Euryomma* Stein.

Genus Fannia R.-D.

I have described one species, *australis*, and recorded another, *canicularis* L., from Australia. There is a third species known to me, but I have only a rather poor male specimen of it on hand, so defer publishing an identification meanwhile.

Genus Euryomma Stein.

I have already dealt with the only known species of this genus from Australia, *peregrinum* Meigen, in a previous paper in this series.

Subfamily Coenosiinae.

This subfamily is a rather poorly defined one. I have been compelled to drop *Atherigona* Rondani and *Pygophora* Schiner as members of it and have transferred them to Phaoniinae. Ultimately it may be necessary to do the same with the other genera, in which case the group would bear the oldest name, *Coenosiinae*.

I have seen but two genera from Australia, which are distinguished as below.

A. Hind tibia with a long anterodorsal bristle near middle and a much shorter one on anteroventral surface distinctly apicad of it ..... *Coenosia* Meigen.

AA. Hind tibia with two long bristles near middle, one on the anterodorsal and the other on the anterior surface, the bases of which are quite close together ..... *Caricea* R.-D.

I have dealt with the species of these genera known to me in the preceding paper in this series.

Subfamily PHAONIINAE.

This is the best represented subfamily in Australia, as it also is in Africa and South America. I give below a key for the identification of the Australian genera known to me at present.

Key to genera.

1. Pteropleura bare 2
   Pteropleura hairy in part 24
2. Third wing-vein bare at base 3
   Third wing-vein with some minute setulae at base 22
3. Mid tibia with a strong ventral bristle near middle ..... *Anaclysta* Stein.
   Mid tibia without a distinct ventral bristle near middle 4
4. Males 5
   Females 14
5. Fore femur with an elongate depression or concavity on apical half of ventral surface at the basal extremity of which there is at least one sharp thorn or spine ..... *Hydrotaea* R.-D.
   Fore femur without a distinct depression or concavity and thorn as above 6
6. Eyes separated by about one-third of the head width 11
   Eyes separated by not more than one-fifth of the head width 7
7. Hind tibia with one outstanding bristle on posterodorsal surface distinctly beyond middle, which is noticeably longer than diameter of tibia .. *Phaonia* R.-D.
   Hind tibia with at most one or two short setulae on posterodorsal surface, none of which is noticeably longer than diameter of tibia 8
8. Auxiliary vein of wing gradually approaching costa, first vein connecting with the latter beyond inter cross-vein; halteres black 9
   Auxiliary vein with a rounded curvature near apex, its junction with costa almost a right angle, first vein connecting with costa before or above inner cross-vein 10
9. Hypopleura bare ..... *Ophyra* R.-D.
   Hypopleura with fine hairs on upper margin in front of spiracle ..... *Australophyra* Malloch.
10. Fourth wing-vein not or very inconspicuously curved forward on apical section; prescutellar acrostichals not noticeably proximad of posterior pair of dorsocentrals ..... *Helina* R.-D.
    Fourth wing-vein rather conspicuously bent forward on apical section; prescutellar acrostichals very noticeably proximad of posterior pair of dorsocentrals ..... *Antipodomyia* Malloch.
11. Costa not extending to apex of fourth wing-vein ..... *Neohelina* Malloch.
    Costa extending to apex of fourth wing-vein 12
12. Hind tibia with only three bristles, one on each of the following surfaces: anterodorsal, anteroventral, and posterodorsal; presutural and anterior postsutural dorsocentral bristles much shorter than usual, hardly distinguishable from the discal hairs and setulae ..... *Atherigona* Rondani.
    Hind tibia with at least four bristles, two on each of the following surfaces: posterodorsal and anterodorsal; all dorsocentral bristles long and strong .. 13
13. Each orbit with the two upper bristles directed backward, the anterior one of these not much longer than posterior one and not placed close to the bristle in front of it ..... *Lispocephala* Mik.
    Each orbit with the upper two bristles directed backward, the anterior one much longer than the posterior one and much closer to the bristle anterior to it than it is to the posterior one ..... *Pygophora* Schiner.
14. Interfrontalia with a pair of cruciate bristles 15
    Interfrontalia without a pair of cruciate bristles, sometimes with scattered fine hairs 17
15. Hypopleura with hairs on upper margin in front of spiracle .. *Australophyra* Malloch.
    Hypopleura bare 16
16. Ocellar triangle highly glossy, black ..... *Ophyra* R.-D.
    Ocellar triangle more or less shining, not highly glossy ..... *Hydrotaea* R.-D.

17. Hind tibia with one outstanding bristle on posterodorsal surface beyond middle, which is noticeably longer than tibial diameter; dorsocentrals all long ..... *Phaonia* R.-D.
Hind tibia either without a bristle on posterodorsal surface or with several short setulae, or two long bristles; if with one it is at middle and short, and the anterior dorsocentral thoracic bristles are quite short and inconspicuous .. 18
18. Hind tibia with one short bristle at middle on posterodorsal surface; anterior dorsocentral bristles short and inconspicuous ..... *Atherigona* Rondani.
Hind tibia without long posterodorsal bristles 19
Hind tibia with two long posterodorsal bristles 20
19. Fourth wing-vein not or almost imperceptibly curved forward apically; prescutellar acrostichals in line with or behind the posterior pair of dorsocentrals ..... *Helina* R.-D.
Fourth wing-vein quite noticeably curved forward apically; prescutellar acrostichals distinctly in front of posterior pair of dorsocentrals ..... *Antipodomyia* Malloch.
20. Costa not extending to apex of fourth wing-vein ..... *Neohelina* Malloch.
Costa extending distinctly to apex of fourth wing-vein 21
21. The two upper bristles on each orbit almost uniform in length, the anterior one not close to the bristle in front of it ..... *Lispocephala* Mik.
The uppermost of the two upper bristles on each orbit much smaller than the second one, the latter much closer to the one anterior to it than to upper one ..... *Pygophora* Schiner.
22. Face with a vertical carina in middle ..... *Rhyncomydaea* Malloch.
Face without such a carina 23
23. Prosternum setulose on sides ..... *Limnophora* R.-D.
Prosternum bare ..... *Myiospila* R.-D.
24. Prosternum bare ..... *Metopomyia* Malloch.
Prosternum haired in part ..... *Dichaetomyia* Malloch.

Genus Hydrotaea R.-D.

There is but one species of this genus known to me from Australia, *australis* Malloch. Macquart described another species, *fuscocalyptrata*, but I have not seen it.

Genus Phaonia R.-D.

But two species of this genus are known to me, *fergusoni* Malloch and *umbrinervis* Stein. I redescribed this last species under the name *parvula* in 1921. I have what I consider may prove to be a third species; having but one male available I defer describing it as new.

Genus Ophyra R.-D.

There are two species of this genus known to me from Australia, *nigra* Wiedemann, and *chalcogaster* Wiedemann, both of which occur throughout the Orient. I keyed the species of this genus known to me in a recent paper (*Ann. Mag. Nat. Hist.* xi, 1923, 664).

Genus Australophyra Malloch.

There is but one species of this genus, *analis* Wiedemann, confined to Australia, so far as I know at present.

Genus Helina R.-D.

This genus is well represented in Australia. I present a key to the species known to me at present, some of which are new to science.

Key to the species of Helina.

1. Halteres black or fuscous (cf. *trinubilifera*) 2
Halteres yellow or brownish-yellow 14

2. Abdomen not bluish or greenish, more or less bronzy, and with an iridescent cast, the apices of abdominal tergites violaceous; a black spot at apex of auxiliary vein, another over inner cross-vein, and one on each extremity of outer cross-vein; sternopleurals 1:2; eyes of male separated by about one-fourth of the head width; arista plumose ..... *iridescens* Malloch.

Abdomen black-blue, blue, blue-green, or green, with or without whitish pruinescence, the apices of tergites not darker than the remainder; sternopleurals 1:2; arista plumose; eyes of males never separated by more than one-sixth of the head width 3

Abdomen black, with distinct brownish-grey or gray pruinescence, always with paired blackish dorsal spots, at least in males; sternopleurals 2:2; arista short-haired or pubescent, longest hairs very rarely as long as width of third antennal segment; cross-veins of wings usually distinctly clouded 11

3. Calyptrae, or at least the lower one, with fuscous or black margins and fringes .. 4
Calyptrae entirely pale, margins and fringes whitish or yellowish 8

4. Narrowest part of frons in male over twice as wide as third antennal segment; thorax with one or two pairs of strong presutural acrostichal bristles .... *australasiae* Malloch.

Narrowest part of frons in male about as wide as third antennal segment; thorax without differentiated presutural acrostichal bristles 5

5. Postsutural dorsocentral bristles three pairs 6
Postsutural dorsocentral bristles four pairs 7

6. Smaller species, 4 mm. in length; thorax with faint pruinescence and very faintly vittate, abdomen not pruinescent; hypopleura bare .... *tasmaniensis* Malloch.

Larger species, about 7 mm. in length; thorax very distinctly vittate; abdomen with dense pruinescence, more or less checkered ..... *hypopleuralis*, n. sp.

7. Basal abdominal sternite bare; hind tibia without an anteroventral bristle at middle ..... *whitei* Malloch.

Basal abdominal sternite hairy; hind tibia with a median anteroventral bristle ..... *hirtibasis* Malloch.

8. Thorax with 4 pairs of postsutural dorsocentral bristles ..... *regina* Malloch.
Thorax with 3 pairs of postsutural dorsocentral bristles 9

9. Thorax black, without blue tinge, with rather dense whitish pruinescence; hind tibia with two anterodorsal bristles and no outstanding anterior setulae; lower calyptra much narrower than usual ..... *calyptrata* Malloch.

Thorax and abdomen blue or green, with whitish pruinescence, that on abdomen very thin 10

10. Thorax blackish-blue, abdomen blue; hind tibia with three or more anterodorsal bristles; wing without brown margins to veins ..... *caerulescens* Stein.

Thorax and abdomen green, the former pruinescent, the latter without whitish pruinescence; hind tibia with two anterodorsal bristles; wing-veins margined with brown, the cross-veins most conspicuously so ..... *howei* Malloch.

11. Thorax with 4 pairs of postsutural dorsocentral bristles 12
Thorax with 3 pairs of postsutural dorsocentral bristles 13

12. Eyes of male very closely contiguous ..... *nigrescens* Stein.
Eyes of male separated by more than the width of third antennal segment .... *nigrohalterata*, n. sp.

13. Legs entirely black; margins of calyptrae fuscous in male, yellowish in female ..... *castigata*, n. sp.

Tibiae tawny, remainder of legs black, margins of calyptrae yellowish in both sexes ..... *simulata* Malloch.

14. Thorax testaceous yellow, with or without distinct blackish vittae; sternopleurals 1:2 15

Thorax black, nowhere yellow 16

15. Longest hairs on arista much shorter than width of third antennal segment; thorax with one pair of strong presutural acrostichals; head black; legs yellow, tarsi black ..... *imitatrix* Malloch.

Longest hairs on arista longer than width of third antennal segment; thorax without strong presutural acrostichal bristles 16

16. Thorax with 4 pairs of postsutural dorsocentral bristles; head yellow, third antennal segment and sides of frons black; thorax with three broad varicoloured dark vittae; apices of femora and tarsi black ..... *fuscoflava* Malloch.
Thorax with 3 pairs of postsutural dorsocentral bristles; head entirely black; thorax with a fuscous dorsocentral vitta; femora yellow, tarsi black ..... *flavofusca* Malloch.

17. Thorax with 4 pairs of postsutural dorsocentral bristles 18
Thorax with 3 pairs of postsutural dorsocentral bristles 23

18. Longest hairs on arista longer than width of third antennal segment; legs tawny, tarsi fuscous; cross-veins of wings not noticeably clouded; fore tibia without a median posterior bristle; fore femora of female normal 19
Longest hairs on arista very much shorter than width of third antennal segment; at least a part of femora in addition to tarsi fuscous in males; inner cross-vein and sometimes also the outer one distinctly clouded; fore tibia with a median posterior bristle; fore femora in female with a scale-like downward extension at apex on anterior side and a large flat bare area at base on same side 21

19. Antennae and palpi black; presutural acrostichal bristles absent or very weak ..... *antarctica* Macquart.
Antennae partly, palpi entirely yellow 20

20. Thorax with one pair of long presutural acrostichal bristles; hypopleura pilose below spiracle ..... *adversa*, n. sp.
Thorax without presutural acrostichals; hypopleura bare .... *vandiemani* Malloch.

21. Legs black; hind tibia on male with a series of very long bristles on anteroventral and another on posterior surface; fore femur of female with the apical scale-like extension short and inconspicuous ..... *poecilventris* Malloch.
At least the tibiae tawny; hind tibia of male with from two to four short anteroventral bristles and no series as above; fore femur of female with the apical scale-like extension very distinct 22

22. Femora almost entirely black in male, only the extreme apices yellowish, in female the apices are broadly yellowish; fifth sternite of male with normal hairs; fore femur in female much thicker than usual, with the flat basal area on anterior side covering nearly the basal half, the apical anterior scale very large ..... *addita* Walker.
Femora of male broadly yellowish at apices, those of female entirely yellow; fifth sternite in male more densely haired than usual; fore femur in female but little thickened, the oval bare flat area at base on anterior side not one-fourth of the femoral length, apical scale not very large ..... *piliventris* Malloch.

23. Wings with a fuscous spot close against third vein just beyond outer cross-vein; both cross-veins broadly clouded; longest hairs on arista distinctly shorter than width of third antennal segment; fore tibia with a median posterior bristle; knobs of halteres brown ..... *trinubilifera* Malloch.
Wing without a spot in first posterior cell as above; cross-veins clouded or clear 24

24. Cross-veins of wings conspicuously clouded 25
Cross-veins of wings not noticeably clouded 26

25. Longest hairs on arista much shorter than width of third antennal segment; fore tibia with a median posterior bristle; presutural acrostichal bristles absent ..... *victoria* Malloch.
Longest hairs on arista about as long as width of third antennal segment; fore tibia without a median posterior bristle; thorax with one pair of presutural acrostichal bristles ..... *simulata* Malloch.

26. Bristles on anteroventral surface of hind femur extending from base to apex; neither the median posterior bristle on fore tibia nor posterior setulae on hind tibia present; no strong presutural acrostichals present ..... *micans* Malloch.
Bristles on anteroventral surface of hind femur confined to apical half, or, if present on almost the entire length, there is a bristle at middle of posterior surface of fore tibia or there are setulae on posterior surface of hind tibia .. 27

27. Fore tibia with a median posterior bristle; hind femur with an almost complete series of anteroventral bristles; thorax with a pair of short presutural acrostichal bristles; hind tibia without posterior setulae 28
Fore tibia without a posterior median bristle 29

28. Legs entirely yellow ..... *versicolor* Stein.
Legs yellow, tarsi black ..... *spilariformis* Malloch
29. Thorax without a strong pair of presutural acrostichal bristles; abdomen without a brassy or violaceous tinge; posterior setulae on hind tibia absent ..... *achaeta* Malloch.
Thorax with a long pair of presutural acrostichal bristles; abdomen with brassy or violaceous reflections; hind tibia with one or more weak setulae on posterior surface near middle ..... *aeneiventris* Malloch.

N.B.—The descriptions of most of the species ascribed to the writer appeared in the series of papers published in the *Annals and Magazine of Natural History*, under the title "Exotic Muscaridae" from 1921 to date.

HELINA HYPOPLEURALIS, n. sp.

♀.—Head black, orbits, face and cheeks with slight whitish pruinescence. Thorax black, slightly gray pruinescent, dorsum with four dark vittae, most distinct in front of suture. Abdomen blue-black, with whitish pruinescent checkerings. Legs black. Wings slightly yellowish. Calyptra white, the margin of lower one fuscous. Knobs of halteres brownish-black.

Frons at anterior margin about one-third of the head width, narrowed behind, triangle shining, narrow, extending to anterior margin of frons, each orbit with two upper bristles directed backward; third antennal segment about three times as long as second; arista plumose; parafacials very narrow; cheek about twice as high as width of third antennal segment; eyes short haired. Thorax with 2 + 3 pairs of dorsocentral bristles, two postsutural intra-alars, prealar moderately long, and no outstanding presutural acrostichal bristles; prescutellar pair of acrostichals long; sternopleurals 1:2; hypopleura haired below spiracle; hairs not descending on sides of scutellum. Basal abdominal sternite bare; genitalia normal. Fore tibia without a median posterior bristle; mid femur without ventral bristles; mid tibia with three posterior bristles; hind femur with two or three preapical anteroventral bristles; hind tibia with only two bristles, on anterodorsal surface. Fourth vein slightly curved forward at apex.

Length, 7 mm.

Type, E. Dorrigo, N.S.W., 30 January, 1923.

HELINA NIGROHALTERATA, n. sp.

♂.—Similar to *addita* Walker in colour, chaetotaxy, and general habitus. Entirely black, thorax quadrivittate, abdomen with a pair of dark spots on second, and another on third visible tergite, legs black, both cross-veins of wings clouded, the outer one least noticeably so. Calyptra dirty yellow. Knobs of halteres blackish.

Eyes hairy; frons at narrowest part distinctly wider than third antennal segment; arista with its longest hairs a little longer than its basal diameter; cheek about three times as high as width of third antennal segment. Thorax 2—3+4 pairs of dorsocentral bristles, two pairs of long presutural acrostichals, and the prealar minute; sternopleurals 2:2. Abdomen as in *addita*, the bristles quite long and strong. Fore tibia without a median posterior bristle; fore femur normal; mid femur with three or four long posteroventral bristles on basal half; mid tibia with three or four posterior bristles; hind femur with an almost complete series of anteroventral bristles; hind tibia usually with three anteroventral and two anterodorsal bristles, and a few posterior setulae. Fourth wing-vein not bent forward at apex.

Length, 7.5 mm.

Type, Gisborne, Victoria, 2 April, 1922 (G. Lyell).

HELINA CASTIGATA, n. sp.

♂. ♀.—Male similar to preceding species, differing in having the frons narrower, the postsutural dorsocentrals three pairs, the abdominal dorsal spots much larger, subtriangular, and rather poorly defined, with a central dark line between them, and the hind femur with the anteroventral bristles present only on apical half.

The fore femur in female is normal.

Length, 5-6 mm.

Type, male, allotype, two male and two female paratypes, Eungella Ra., 45 miles west of Mackay, Queensland, 1,400-2,400 feet, 13 to 25 Sept., 1923 (Goldfinch).

HELINA ADVERSA, n. sp.

♀.—Head black, antennae and palpi orange-yellow, apical half of third segment of former fuscous. Thorax and abdomen black, with gray pruinescence, the former faintly vittate, the abdomen with a dotted appearance. Legs orange-yellow, tarsi black. Wings clear, yellow at bases. Calyptra and halteres yellow.

Eyes pubescent; arista plumose. Thorax with 2 + 4 pairs of dorsocentral bristles, and one pair of long, strong, presutural acrostichals; prealar short; sternopleurals 1:2; hypopleura with some hairs below spiracle; hairs not descending on sides of scutellum. Abdomen normal. Fore tibia without a median posterior bristle, femur normal; mid femur without ventral bristles; mid tibia with three posterior bristles; hind femur with two or three preapical anteroventral bristles; hind tibia with two anterodorsal and one anteroventral bristle, and a short posterodorsal bristle beyond middle. Venation of wings normal.

Length, 8 mm.

Type, Fish River, N.S.W., 25 March, 1923.

There are one or two more species of this genus in my possession, but I consider that, owing to the very large number of species that have been already described, it is advisable to put forward, at this time, the foregoing key so that anyone who is interested in the group may be enabled to identify the more common species and, at the same time, get an idea of the various characters used in the differentiation of the species. Later on, when I have received all possible material in the genus, I may give a complete key to the species, but there is always the danger that, by putting off the presentation of a key, one may do so until such a presentation becomes impossible for some reason over which one may have no control. I shall always be glad to examine and report upon species of the genus should such be sent me.

Practically nothing is known of the larval habits of the genus elsewhere and of the Australian species we know nothing at present, so that here is a good field for biological investigation.

Genus ANTIPODOMYIA Malloch.

But one species of this genus is known, *bancrofti* Malloch.

Genus NEOHELINA Malloch.

The two species of this genus were diagnosed in my last paper on Australian Diptera.

Genus ATHERIGONA Rondani.

There are several species of this genus known to me from Australia, one of which, *excisa* Thomson, is very widely distributed, occurring in the Americas,

Africa, and from Southern Asia to Australia. The larva lives in decaying fruits. Another species, *tibiseta* Malloch, is known at present only from Australia. Lack of males of other species prevents me from dealing with the whole genus at this time.

Genus LISPOCEPHALA Mik.

Stein described *tinctipennis* from Australia. This species is unknown to me. He also places *intacta* Walker in this genus, with a doubt. I intend to revise the genus shortly, its limits at present being but imperfectly understood.

Genus PYGOPHORA Schiner.

There are two species definitely known to me from Australia, *apicalis* Schiner, the genotype, and *minuta* Malloch. I believe that there is a third species, but have so far seen only female specimens of it.

Genus RHYNCOMYDAEA Malloch.

There are two species of this genus in Australia, *carinata* Stein, and *australis* Malloch.

Genera LIMNOPHORA R.-D., MYIOSPILA R.-D., and DICHAETOMYIA Malloch.

I have already dealt with the species of these genera known to me from Australia in this series of papers.

Genus METOPOMYIA Malloch.

There is but one species of this genus known, *atropunctipes* Malloch.

Subfamily MUSCINAE.

This subfamily, as here limited, contains comparatively few genera, but some of these are of great economic importance as they transmit certain diseases or in other respects injure man and domestic animals. Unfortunately I have seen but few specimens of the subfamily from Australia and cannot give a list of the native species at this time. I give here a key for the separation of those genera which I believe must occur, or which I have definite records of as having been found in Australia.

Key to genera.

1. Propleura hairy in centre, i.e. below the humerus and above the propleural bristles; fourth wing-vein angularly bent forward at middle of its apical section; suprasquamal ridge not setulose posteriorly ..... *Musca* Linné
   Propleura not haired in centre 2
2. Suprasquamal ridge with setulose hairs posteriorly 3
   Suprasquamal ridge not setulose posteriorly 4
3. Fourth wing-vein subangularly bent forward at middle of its apical section; species not metallic blue or green in colour ..... *Viviparomusca* Townsend.
   Fourth wing-vein with a rounded forward curvature at middle of its apical section; species metallic blue or green in colour ..... *Orthellia* R.-D.
4. Prosternum, pteropleura, and hypopleura bare ..... *Baliosglutum* Aldrich.
   At least part of the hypopleura or pteropleura haired 5
5. Pteropleura with one or two bristles and some hairs above 6
   Pteropleura bare 8
6. Fourth wing-vein subangularly bent forward close to middle of its apical section; species not metallic in colour on any part of body; frontal orbits without strong forwardly directed bristles at middle; prosternum haired ..... *Biomyia* R.-D.
   Fourth wing-vein with a rounded forward curvature near middle of its apical section; species blue-black, or metallic blue or green in colour; frontal orbits of female each with a strong forwardly directed bristle near middle; prosternum hairy or bare 7

7. Species metallic blue or green in colour; mid tibia with a strong median ventral bristle; prosternum bare ..... *Pyrellia* R.-D.
Species blue-black in colour; mid tibia without a strong ventral median bristle, sometimes one present on middle of posteroventral surface; prosternum haired on sides ..... *Morellia* R.-D.
8. Arista pubescent: prosternum hairy ..... *Synthesiomyia* B. & B.
Arista plumose: prosternum bare 9
9. Presutural acrostichals well developed; hairs on hypopleura below spiracle .....
..... *Passeromyia* Villeneuve.
Presutural acrostichals not developed; hairs on hypopleura on upper margin in front of spiracle and also below spiracle ..... *Graphomyia* R.-D.

Genus Musca Linné.

I have insufficient material in this genus to justify me in dealing with the Australian species, but I suspect that only one species, *domestica* Linné, belongs here, though there may be another which I have not yet seen.

Genus Viviparomusca Townsend.

This genus was erected for the reception of *Musca vivipara* Port., but I believe most, if not all, of the viviparous species belong in it. The exact distribution of *vivipara* has yet to be determined, and it may be very widely spread.

Genus Orthellia R.-D.

This genus is known also as *Cryptolucilia* and *Pseudopyrellia*. My material does not permit an opinion as to the number of Australian species at this time. I have, however, seen *lauta* Wiedemann from Australia.

Genus Biomyia R.-D.

One or two of the Australian species recorded as *Musca* belong here.

Genus Balioglutum Aldrich.

Only one species, *illingworthi* Aldrich, belongs in this genus. It occurs in Queensland.

Genus Synthesiomyia Brauer and Bergenstamm.

One species of this genus is known, *nudiseta* van der Wulp.

Genus Passeromyia Villeneuve.

But one species of this nestling infesting genus, *longicornis* Macquart (*heterochaeta* Villeneuve), occurs in Australia. Townsend described it under the name *victoria*.

Genus Graphomyia R.-D.

One Australian species seen by me belongs to this genus.

Genus Pyrellia R.-D.

I have no species of this genus from Australia, but *serena* Meigen is known to occur.

Genus Morellia R.-D.

I have not yet seen any species of this genus from Australia. The species occur usually in the higher altitudes and it may be turned up in this continent yet.

Subfamily Stomoxydinae.

I have seen only the genus *Stomoxys* from Australia, but present a diagnosis for the separation of this genus and *Lyperosia*.

A. Palpi very much shorter than proboscis; centre of propleura haired .....
..... *Stomoxys* Geoffroy.
AA. Palpi as long as proboscis or almost so; centre of propleura bare .....
..... *Lyperosia* Rondani.

A FEW OBSERVATIONS ON THE GEOLOGY AND GEOGRAPHY OF NORTH-WEST AND DESERT BASINS, WESTERN AUSTRALIA.

By Frederick G. Clapp.*

(Communicated by Professor Sir T. W. Edgeworth David.)

(Plates xvi-xix and five Text-figures.)

[Read 29th April, 1925.]

Introduction.

During seven months of the year 1924 I had an opportunity of making nearly 6,000 miles of geological traverses in northwest Western Australia, and in so doing I visited some localities that had never been studied geologically and others that had been but little studied. In the absence of sufficient time to prepare a detailed account of geological and geographical conditions in the country traversed, some outstanding features are presented herewith for the information of future investigators.

The study does not pretend to be a finished one in any sense, except insofar as it was carried to a logical conclusion in connection with certain areas under option to my client for the purpose of determining certain economic conditions. Time was so much a factor that I even found it necessary to pass entirely, or to make extremely hasty visits to important geological localities in the vicinity of traverses, for business reasons, and to omit entirely certain other localities which, from the viewpoint of pure geology, would have been considered essential to a solution of the problems outlined in this paper. If my discussions appear one-sided, if they are devoted to certain areas in contradistinction to others of greater geological importance, or if some hypotheses advanced are later found untenable, I hope, at any rate, that the information may prove helpful. The country is a vast one and little known, the Government Geological Survey is handicapped by insufficient funds, and the duty of a geologist is obviously to help the cause of science by placing on record any information at his disposal.

The country investigated covers in a general way the greater part of what are known as Desert Basin and Northwest Basin (Fig. 1),† both of which consist predominantly of Permo-Carboniferous strata (Figs. 2 and 3). My routes of necessity traversed rocks of this age and also overlying sediments as well as older systems on the borders of the two Basins. Vast areas were never visited, but

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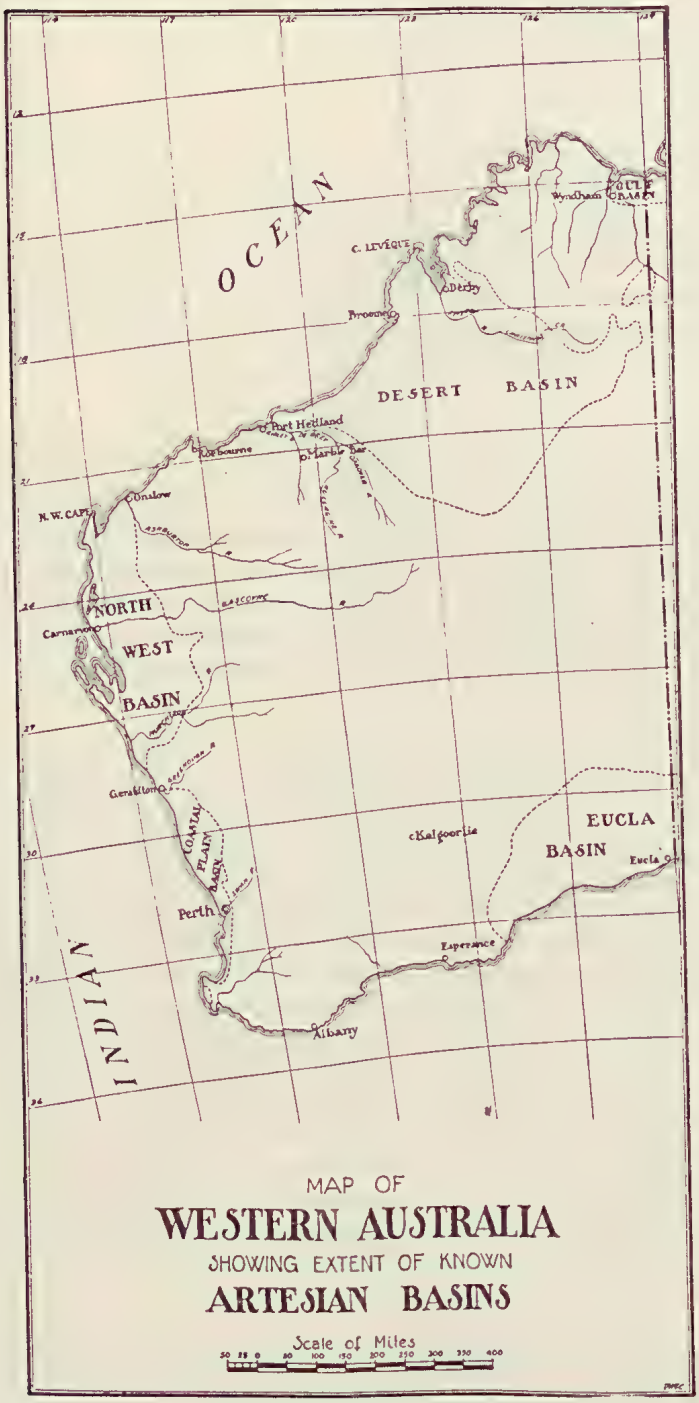
* Published with the permission of Mr. A. E. Broué, of 11 Castlereagh Street, Sydney, N.S.W., for whom the investigations in Western Australia were undertaken.

† Fig. 1, representing the positions of the basins, was taken from an old map and has not been corrected to include new discoveries in outline of Desert Basin, such as are described in this paper.



Text-fig. 1.—General map of Western Australia, showing relative positions of Desert Basin and Northwest Basin.

available information supplied by other geologists has been freely used. Desert Basin covers a large portion of Kimberley, Northwest and Eastern Divisions of Western Australia, whereas Northwest Basin is situated entirely in Northwest Division. This paper should be read together with frequent reference to the geological map of Western Australia, published as Plate I in Chapter I of The Mining Handbook, Memoir No. 1 (1919), by Mr. A. Gibb Maitland.

Outline of physical features.

The topographical features of Western Australia have been previously classified into (1) Coastal Plain, (2) Hill Ranges and (3) Interior Plateau. In the country traversed, the width of Coastal Plain is nil in places between Port Hedland and Onslow, but expands to 100 miles or more in Gascoyne District of Northwest Division. Between Broome and Wollal in Desert Basin, this plain merges with the Interior Plateau so gradually that no boundary can be pointed out, and the Hill Ranges are missing.

In order to maintain a consistent basis of discussion, the Coastal Plain is here considered as being practically synonymous with the area of Tertiary age; nevertheless such anomalies exist as "Cape Range," west of Exmouth Gulf (Fig. 4 and Plate xvii, fig. 2), which is of Tertiary age and over 1,000 feet high, although no other land east of Hill Ranges has an equal height. Another inconsistency in the above mentioned synonym is that, in Gascoyne and Lyndon Districts of Northwest Division, much of the country that is topographically Coastal Plain is of Jurassic age.

Such Ranges as Kennedy, Carrandibby and others (Fig. 3) in Northwest Basin, and Dampier and Edgar Ranges in Kimberley are topographically part of the Interior Plateau and are of Permo-Carboniferous age. My observations lead to the opinion that the term "Great Plateau" or "Interior Plateau" should be used with discrimination, for, in both basins, it merges on the west with the Coastal Plain; and even over 100 miles in the interior, midway between Dampier Range and De Grey River, I have found the so-called "plateau" to be only 300 feet above sea-level (barometrically).

General remarks on the geology.

Although geological work in this portion of the State is in its infancy, many valuable reconnaissances have been made, and all explorers have contributed to present knowledge. Mr. E. T. Hardman, pioneer observer and one-time Government Geologist, conducted explorations in 1883 and 1884,* on which subsequent mapping has been based; and his mapping is accepted in areas in which my observations overlapped his. The work of Messrs. Gibb Maitland and Talbot of the present geological survey has been of tremendous value, as have reports made by other men† in the employ of the Government; and certain private investigators, whose work has not been published and whose names I am not at

* Hardman, Edward T.: Report on the geology of the Kimberley District, Western Australia; published by the Government Printer, Perth, 1884, pp. 1-22, with 16 plates; also geological map published separately.

† Woodward, H. P.: Geological sketch map showing the possible artesian water area between the Minilya and Ashburton Rivs., 1907 (in two sheets); and others.

liberty in all cases to mention, have given valuable information* as to conditions in portions not personally visited. Other publications, by Talbot, Jack and others, a valuable paper on the physiography of Australia by Prof. Griffith Taylor and a report by Gibb Maitland in the Proceedings of the Third Interstate Conference on Artesian Waters have been considered, but the references are not quoted, as the records are not now accessible to me.

Nearly all of my work lay in the Northwest and Desert Basins, and the economic problems were limited to those basins; therefore I will refrain from discussion of observations outside them, except such as bear on the Basin problems. Explorations were limited to areas of Recent, Quaternary, Tertiary and Permo-Carboniferous sediments, overlapping in a few instances into granitic areas of unknown age, Nullagine and Pre-Cambrian sediments and metamorphics. The essential characteristics of these formations have appeared in an excellent summary by Gibb Maitland.†

General Similarity of Northwest and Desert Basins.

One might suppose that Northwest and Desert Basins have few characteristics in common. For instance, they are separated by a belt of Pre-Cambrian rocks 350 miles wide where narrowest and which rise in places to over 4,000 feet above sea-level. Desert Basin is roughly quadrilateral in shape, with its longer diameter approximately at right angles to the coast; whereas Northwest Basin, like the "Coastal Plain Basin" farther south, constitutes a belt nowhere more than 150 miles wide, parallel to the coast from Onslow to Murchison River. Desert Basin is roughly 325 miles in a northeast-southwest direction by over 450 miles northwest-southeast. On the other hand, Northwest Basin extends 400 miles north and south by 75 to 150 miles east and west.

A popular conception of Desert Basin is that it constitutes a desert, as the name implies. As a matter of fact, large areas of Desert Basin are so barren and sandy as to have practically a desert charcter, whereas the greater part of Northwest Basin is prosperous pastoral country, in which two score artesian wells have been sunk, yielding some of the greatest flows in the Commonwealth and proving an area of perhaps 15,000 square miles to have artesian possibilities.

It must be remarked by anyone who glances at the geological map of the State, that the principal stratigraphical divisions (Tertiary, Jurassic, and Carboniferous) in the two Basins are identical. Furthermore, the details of stratigraphy throughout portions of the basins examined by me are so closely identical as to leave no doubt that the basins were once connected, either across the intervening 350-mile wide Pre-Cambrian and Nullagine Plateau or through Indian Ocean around the north end of this Plateau. In both Basins the Permo-Carboniferous system has been sub-divided into (1) "an Upper or Sandstone group," made up almost entirely of sandstones and analogous porous sediments, and (2) "a Lower or Marine group" (in which limestones appear to predominate). The limestones are interlaminated with sandstones, shaly sandstones, and thin shales.

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* Among these are unpublished reports by T. A. Blatchford, dated 20 Dec., 1923, by H. W. Talbot dated 19 Nov., 1923, by D. J. Mahony (undated), by Leo J. Jones and E. De Villa.

† Gibb Maitland, A.: A summary of the geology of Western Australia. *The Mining Handbook, Geol. Survey Memoir* No. 1, Chapter I, 1919, pp. 7-55, 80 figs. and geological map.

North escarpment of the Interior Plateau in Desert Basin.

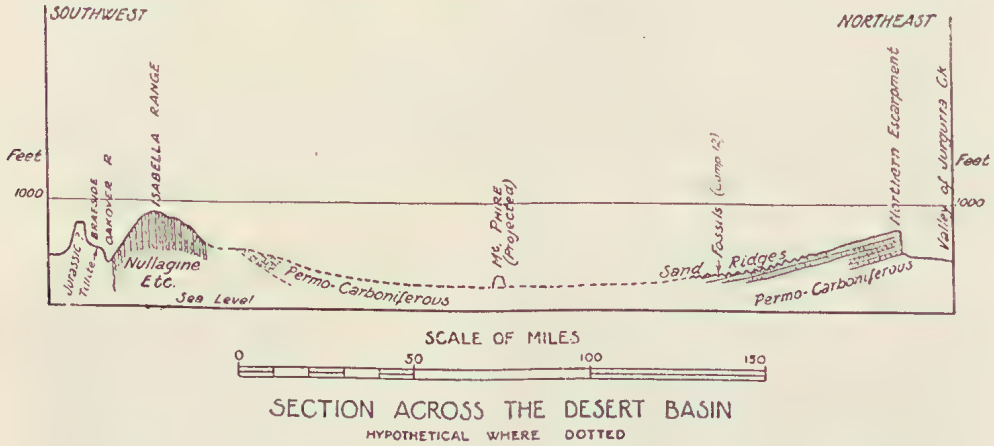
The north escarpment of the Interior Plateau constitutes a vast geographical feature. Commencing 77 miles southeast of Broome, or 35 miles southeast of Hamilton's well, the escarpment first appears merely as a breaking away of the coastal type of country, known as "pindan sands," which extend to that point from the inner edge of the "sea-level plains" near Broome. The pindan sands, covered with a thick growth of many varieties of trees and shrubs, rise from sea-level to a height of perhaps 200 feet at Hamilton's well and to about 700 feet at the "breakaways" mentioned. A few low hills in the vicinity rise a few rods higher; hence the name "ranges" by which they are generally known. Some person more or less familiar with that part of the country has suggested the name "Dampier Ranges" to distinguish them from Edgar Ranges, situated farther east in the vicinity of Jurgurra (popularly called "Jeegully") Creek, which I did not have an opportunity of visiting.

The claim of the height of land along the north escarpment of the plateau to the designation "ranges" consists, firstly, in a slight steepening of the northeastward rise of the Plateau along the line where the Desert sandstones rise from beneath the plains of the west and south, and secondly, in erosional dissection of the sandstone itself, where it drops abruptly 100 to 300 feet into "breakaways" tributary to a broad valley, which thence descends slightly northward and constitutes part of the Fitzroy lowland. A generalized section across Desert Basin is shown in Fig. 2, from which the formations are seen to dip southwest at an angle of 1 to 2 degrees; hence the escarpment is typical of those the world over on up-dip flanks of structures exposed in high-lying sandstones. Calculations based on observed dips in the escarpment and those on the coast and in Mt. Phire (see below) lead me to the opinion that the strata of the escarpment and higher beds may have a total thickness of as much as 10,000 feet.

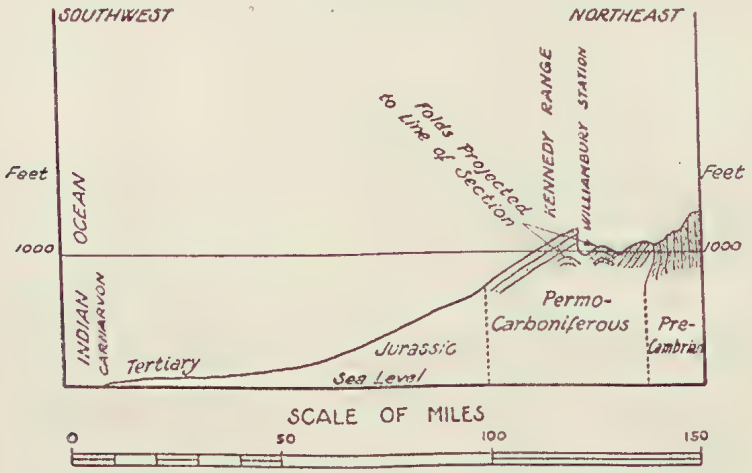
Whereas the valley north-east of the escarpment, at the place, 77 miles southeast from Broome, where touched by my motor road from Broome to Camp 12, can be reached by an easy grade of not over 100 feet per mile, and whereas the crest of the Plateau is accessible on its west side by an even more imperceptible grade, the valley descends eastward and the "ranges" or Plateau crest rises somewhat southeastward, so that within a mile of the northwest termination of the escarpment it becomes nearly 100 feet high and a few miles farther southeast it is precipitous to a height of 200 feet or more. Many isolated tablelands with flat tops, a few acres up to several hundred acres in extent, stand in this valley, and are only higher than the main Plateau by an amount equal to the normal rise in dip toward the northeast (a few rods per mile). Maps of the Lands Department show several of these outliers—named Goorda Tower, Babrongan Tower, Mt. Alexander, Mt. Jarlemai, etc.—far to the northeast, and some of these were visible in the distance from points visited on the north edge of the escarpment.

The rocks of the north Plateau escarpment are fine-grained white sandstones, somewhat aluminous, but never calcareous or even approaching the consistency of shale. In places they contain numerous ferruginous concretions. The dip is southwest and ranges from nothing up to 2 degrees. In a few localities, as at the head of a deep "'breakaway" at Camp 9, 130 miles southeast of Broome, areas were seen up to 3 miles in length and a few hundred feet wide composed of a hard, light gray to white quartzite capping the Plateau a short distance back from the escarpment. It is only a few feet thick and takes the place of limonitic laterite which is an almost constant feature of any sandstone outcrop in the semi-desert

areas. Quartzite is frequently only a vitrified phase of the surface-hardened sandstones and is common throughout Australia in rocks of all ages. From aerial observers and other sources I have received reports of a great ledge of gray quartzite that extends from a point on the Broome-Derby road some 60 miles northeast of Broome north to near Cape Leveque, and this last-mentioned quartzite may constitute part of the same series of rocks.



Text-fig. 2.—Generalized cross section of Desert Basin from Jurgurra Creek to Oakover River.



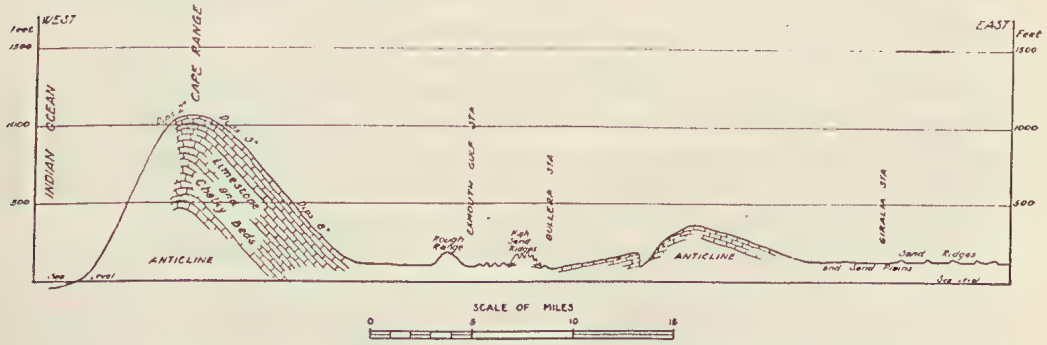
Text-fig. 3.—Generalized cross section of Northwest Basin from Williambury Station to Carnarvon.

In contour the escarpment is not simple, but extends south-east for many miles from its north extremity, and then bends east, forming an irregular line of cliffs throughout—vertical and inaccessible to a vehicle at any point, rarely scalable by man, and the crest of which is accessible to horses only at points dozens of miles apart. From information at hand, the line of cliffs appears to extend east over 200 miles, and it may merge with certain tablelands described by Talbot and others in the vicinity of Canning Stock Route. The "breakaways" in the vicinity of the 123rd meridian indent the Plateau in places for many miles back

of the escarpment proper. Curiously enough, all rock holes that contained water at the time of my visit are situated at the head of "breakaways," except in a few instances where found in canyon-like gorges near the base of cliffs. No water holes, and only a few "native soaks," were found south of the escarpment, and very few natives live in that part of the Plateau.

East escarpment of Kennedy Range.

A comparison of Figs. 2 and 3 will show how similar are the formations and conditions in the escarpment described above to those existing in that of the east edge of Kennedy Range in Gascoyne District of Northwest Division. As in the case of Kimberley, so in that of Gascoyne, the escarpment rises vertically 200 to 300 feet, and apparently can not be ascended by vehicle or animal at any place from its south end, near Gascoyne River, to a point on Merlingleigh Station, a distance of about 50 miles. Even farther north, the cliffs are intermittently abrupt and precipitous for many miles. North and south from Kennedy Range its topographical features are repeated at intervals, represented by a smaller range directly south of Gascoyne River, by Carrandibby Range, 50 miles south, and probably also by Moogooloo Range, north of Minilya River; so that, for over a distance of 150 miles, the escarpment feature is prominent in some degree for intermittent, but long, distances.



SECTION NEAR EXMOUTH GULF

(FROM INDIAN OCEAN ACROSS CAPE RANGE SOUTH 75° EAST TOWARDS WINNING POOL)

Text-fig. 4.—Cross section in vicinity of Exmouth Gulf, showing Tertiary folding.

As with the north Plateau escarpment, so with that of Kennedy Range, the strata consist of fine-grained, white, non-calcareous sandstones, which dip west at angles of less than 5 degrees with only slight reversals (no reverse dip of more than a fraction of a degree for a short distance being visible in the face of Kennedy Range). As with the north Plateau, so with Kennedy Range, the land descends gradually westward from an altitude of approximately 1,000 feet (Plate xix, fig. 1), directly on the escarpment, to the Coastal Plain several hundred feet lower. Somewhere between the west base of Kennedy Range and Indian Ocean, the Permo-Carboniferous rocks pass beneath the Jurassics, which in turn pass beneath Tertiary sediments to the west.

Significance of certain fossil collections.

A point that needs further field attention is the abundant occurrence of large pectenoid valves and others resembling *Productus* in ferruginous conglomeratic

sandstones of hematitic hardness in the semi-desert area about 185 miles, by my tractor road, southeast of Broome (Fig. 2), estimated only a few miles west of McLarty Hills as mapped. This fossil locality lies between 83rd and 87th sand-ridges, counting from the north, and not far from my Camp 12. No outcrops exist between here and the north Plateau escarpment, but those mentioned are plentiful throughout an area of several square miles at an elevation of about 300 feet above sea-level. The fossils are reported by Mr. W. S. Dun to be not definitely determinable, but of probable Permo-Carboniferous age. The outcrops are covered with dark red glaze that takes the place of ordinary laterite in dry arid regions in which the rocks contain much ferruginous matter, and here they are as hard as many regionally metamorphic rocks, although vitrification is due to atmospheric and not to tectonic agencies.

Similar glazing to that which is so prominent near Camp 12 is observable in King's Peaks (two ferruginous sandstone hills about 100 feet high) on the coast roughly 60 miles north of Broome, between King's Peaks and Pender Bay, and in the country between Lagrange and Anna Plains Station back of Ninety Mile Beach. In the last-mentioned locality, one fossil species was found by Mr. B. E. Bardwell and presented to me, but its identity has not been determined. Glazing of the same type is reported by Mr. Gibb Maitland in similar rocks, from an altitude of 1,200 feet above sea-level at Trig. Station K37, on top of the south end of Kennedy Range, just north of Gascoyne River, where he collected unnamed species of *Spirifera*, *Productus*, *Athyris* (?) and *Strophalosia*.

Since outcrops of similar character overlie the Desert Sandstone escarpment in the north and occupy a similar position on Kennedy Range, the results of the determination of the species collected near Camp 12 (if determinable at all) are awaited with interest, to learn whether any further evidence is afforded of the continuity of sedimentation from one Basin to the other, either across the intervening Plateau or through a submarine connection.

Although not necessary for a consideration of any particular problem discussed herein, a publication of the names of identified Permo-Carboniferous species collected on the recent expedition, and determined by Mr. Dun, may be of value. The determinations were made through the agency of Prof. Sir T. W. Edgeworth David and the courtesy of Mr. E. C. Andrews, Government Geologist of New South Wales. The localities are believed to be arranged in stratigraphical order from below upwards (from 1 to 5), but this order is by no means certain. All of the species are believed to be from the so-called "Lower or Limestone series" of the Permo-Carboniferous.

List of identified species of Permo-Carboniferous fossils collected on the expedition to Western Australia.

(Determinations by Mr. W. S. Dun.)

1. From a persistent earthy crinoidal limestone outcropping 6 miles northwest of Lyons River Homestead, between Lyons River and Kennedy Range on road from Lyons River Homestead to Mt. Sandiman Station shearing-shed.

Amplexus pustulosus Hudl.
Crinoid stem ossicles.
Fenestella, sp. undescribed.
Phyllopora, sp. undescribed.
Stenopora, 2 species.
Spirifera marcoui Waagen (sp. by Etheridge, Jr.).
Spirifera musakheylensis (Eth., Jr., not Davidson).

List of identified species of Permo-Carboniferous fossils collected on the expedition to Western Australia—continued.

Spirifera cf. lata McCoy.
Spiriferella australasica Etheridge, Jr.
Cleiothyris macleayana Etheridge, Jr.
Chonetes pratti Davidson.
Productus spines.
Pleurophyllum sp.
Monilopora nicholsoni, Etheridge, Jr.

2. From limestones lying a few feet above Lyons conglomerate, 28 miles southeast of Gascoyne Junction, on road to Dairy Creek Station.
Chonetes pratti Davidson.
Productus, sp. nov. (will be named *P. clarkei*).
Spirifera, sp. undetermined (*musakheylensis* ?).
Spirifera, cf. *marcoui* Waagen.

3. Believed to be from same locality as No. 2 above.
Stenopora, dendroid.
Fenestella, 2 species.
Aulosteges baracoodiensis.
Productus, sp. nov. (will be named *P. clarkei*).
Athyrid (*Cleiothyris macleayana* ?).

4. From flaggy sandstones, 5 miles west of Gascoyne Junction, on road to Carnarvon.
Productus pellus.
Spirifera cf. *lata* (Etheridge and Foord, not McCoy; will be renamed *maitlandi*).
Pleurophyllum australe Hinde.
Chonetes sp. (*pratti* ?).

5. From well, 5 miles northeast of Merlingleigh Station (temporary camp) and east of Kennedy Range.
Spirifera lata Foord, not McCoy.
Spirifera cf. *musakheylensis.*
Chonetes pratti Davidson.

6. From Merlingleigh Station, well, at temporary camp at foot of east side of Kennedy Range.
Spirifera cf. *musakheylensis.*
Spirifera marcoui.

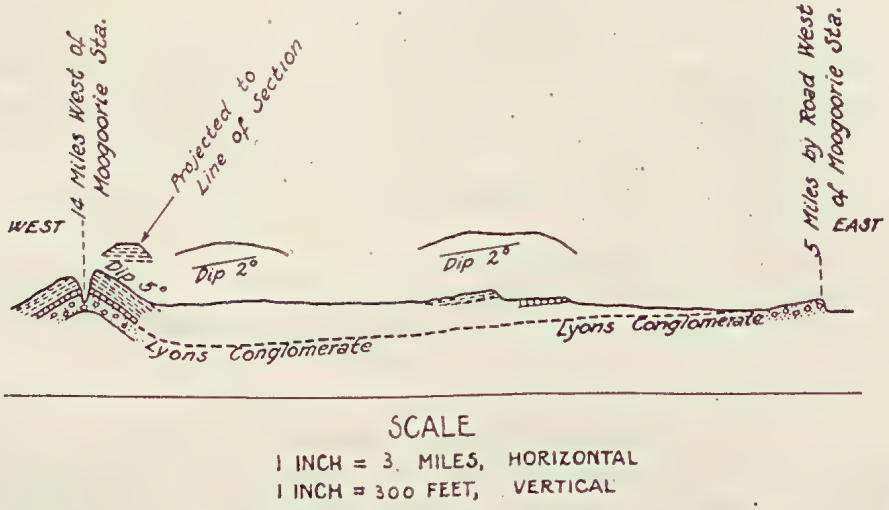
A comparison of the strata in the east escarpment of Kennedy Range with those in the north escarpment of Desert Basin is interesting. In both instances the rock is essentially a fine-grained white or very light gray, frequently soft, porous rock, mainly siliceous to chalk-like, with no ascertainable calcareous admixture. The rock is finely stratified and contains numerous ferruginous and cherty concretions parallel to the bedding. Both the Desert Basin formations and those of Northwest Basin are overlain sea-ward by strata of supposedly Jurassic age, often having similar characteristics to the Permo-Carboniferous and not to be differentiated on lithologic evidence alone.

Structure of beds underlying Plateau beds.

The Permo-Carboniferous age of the two Plateaus, as well as that of outcrops for many miles east and north respectively, has been proven, by Gibb Maitland, on fossil evidence alone. No unconformity has been reported in the series. Nevertheless, the discordance in character and structure of the sub-plateau beds from those constituting the Plateaus is so striking, both in Northwest and in Desert Basins, that, in my opinion, the possibility of the existence of a mid-Permian unconformity should be suggested and tested by exhaustive field examination.

In numerous outcrops examined from Gascoyne Junction, east of Kennedy Range, north to Williambury Station (roughly 85 miles), and southeast to Dairy

Creek Station (50 miles), the rocks dip occasionally in directions opposed to normal, and in places they dip as much as 8 degrees toward the east. In travelling over the motor road from Gascoyne Junction to Dairy Creek Homestead an anticlinal axis is crossed where, a few miles west of that homestead, abnormal and reverse dips cover a breadth of several miles. A similar fold was seen on north side of Gascoyne River between Arthur and Wyndham Rivers, and may or may not be identical with the axis mentioned. Slight east dips were seen at several points between Kennedy Range and Lyons River, between Lyons and Minilya Rivers and they are reported by Mr. E. De Villa and others on Minilya River (in unpublished manuscript). The best dome was seen in the southwest part of Williambury Station, 14 miles west of Moogoorie Homestead (Fig. 5 and Plate xix, fig. 3). This locality is situated 9 miles from the normal outcrop of Lyons conglomerate; yet this is domed upward, together with its overlying sandstones, projecting above the normal surface in a central valley almost entirely surrounded by outcrops, dipping outwards and consisting largely of cliffs up to 50 feet in height.



Text-fig. 5.—Cross section of doming at point on Williambury Station, at north end of Kennedy Range.

Probable Permo-Carboniferous of Dampier Land.

Although the western edge of the peninsula (once known as Dampier Land) west of King Sound is Jurassic, as mapped, I am under the impression that the balance of the peninsula may be largely of similar age to the Plateau escarpment, which is believed to be Permo-Carboniferous. One geological observer is convinced he saw folds in a sandstone north of Wanganut well, on the road from Broome to Beagle Bay Mission. My own impression is that the beds at the particular point are of duller shades than the Plateau beds of the coast and west of Wanganut well, and their elevation of several hundred feet gives the impression that they may constitute a fold against which Jurassic sediments were deposited to the west and south-west. The coarse ferruginous conglomeratic sandstones of King's Peaks (some 60 miles north of Broome on the coast), between Carnot and Beagle Bays,

with their peculiar glaze and hematitic veining, suggest the beds that have been called Permo-Carboniferous near Camp 12 and back of Ninety Mile Beach. Similar hard coarse ferruginous rocks extend near the coast from King's Peaks to Beagle and Pender Bays, but no fossils could be found in them.

Remarks on Lyons conglomerate.

The Lyons conglomerate (Plate xix, fig. 2) is one of the most interesting formations in Northwest Basin. It has been so fully described (Gibb Maitland, *op. cit.*, pp. 34-35) that I need only remark that it is an immense boulder bed—an actual tillite—composed of innumerable ice-scratched pebbles and boulders and having other essential phenomena, extending from Lyndon River, with some interruptions, south for a distance of 400 miles; and its actual outcrop can be traced in Lyndon and Gascoyne Districts for about 200 miles.

In considering the similarity of stratigraphic conditions in the two Basins it may be well to remark that Talbot and others have found a boulder bed in the Fitzroy Valley in the north part of Desert Basin at about the same stratigraphical position, and that a previously unknown tillite locality was recently discovered by myself at Braeside Station, south of Desert Basin.

An interesting feature of the Lyons conglomerate is its presence in the centre of an almost perfect dome, some 9 miles west of its normal outcrop, at a point on Williambury Station, 14 miles west of Moogoorie Homestead and a short distance south of Minilya River. The east side of this dome is shown in Plate xix, fig. 3 and a cross section of the locality appears in Fig. 5.

Other Conglomerates of probable Permo-Carboniferous age.

On Moogoorie Station, intermediate between Minilya and Lyons Rivers, certain conspicuous outcrops of hard, coarse, quartzitic conglomerate occur below the "limestone series" and are almost certainly of Carboniferous or Permo-Carboniferous age. Similar conglomerate, resting on granite, is described by Gibb Maitland (*loc. cit.*, p. 36) at Warrie well, on Towera Station on Yannerie River. Similar outcrops were also seen by me on Pardu Station, near the southwest corner of Desert Basin, and there seems no reason for supposing their age to be other than Permo-Carboniferous, although they might conceivably be Jurassic. The Pardu conglomerates are very ferruginous over many square miles, but an occasional white, unoxidized exposure classes them with a vast succession of white siliceous rocks of varying texture. They bring the known rocks of Desert Basin to within 50 miles of De Grey River or 40 miles farther southwest than reported on the published geological map. The contiguous area of granite is found to be narrower than mapped near the coast, but 100 to 150 miles southeast it is much wider than mapped, even including some of the area mapped as Carboniferous east of Paterson Range.

Features in common to both Basins.

Summarizing the evidence given, it appears that the north escarpment of the interior Plateau in southern Kimberley Division is similar, geologically and geographically, to that bounding the east face of Kennedy and Carrandibby Ranges in Gascoyne and Lyndon Districts of Northwest Division in the following respects:

1. In its height of 100 to 300 feet, either continuously (as in Desert Basin) or throughout intermittent stretches of 20 to 50 miles each, separated by low-lying areas (as in Northwest Basin).

2. In a characteristic whiteness of the escarpment, i.e., in its texture of generally fine (but locally coarse) non-calcareous sandstone.

3. In the fact that both Plateaus are surmounted by sand-dunes, situated on the Plateau edge in part (in Kennedy Range), but 30 miles or more back from the escarpment elsewhere (in Desert Basin).

4. In a characteristic vegetation of spinifex, interspersed with shrubs and low trees, interrupted by sandy patches, but commonly having suitable feed for cattle or sheep.

5. In a continuous dip of the strata from the escarpment into the Plateau, until the latter merges with the low plain to the south or east respectively.

6. In the occurrence of small springs of fresh water on the down-dip side of the "ranges." The only genuine springs of which I know, in the western part of Desert Basin, are situated 45 miles east of Anna Plains Homestead and have been rarely visited; and in Northwest Basin many springs emerge along the west side of Kennedy Range. An interesting fact is that only saline waters are commonly found in bore holes 50 to 100 feet deep on the low plain directly east of the Kennedy and Carrandibby Range escarpments and that saline springs flow continuously from a few spots on that side of the ranges and directly north of Gascoyne River. That is, fresh water exists in outcropping strata on the down-dip side of Kennedy Range and saline water on its up-dip side. A "salt marsh" is reported by the Lands Department over a practically sea-level plain, situated, roughly, 35 miles southeast of Anna Plains Homestead in Desert Basin; and wells sunk on sea-level plains between Edgar and Pardu Stations (back of Cape Villaret and Ninety Mile Beach respectively) are frequently saline, but this salinity is attributed to another cause than those pertaining to wells in Permo-Carboniferous strata.

7. The beds of both escarpments are flat or have a dip of less than 5 degrees, and they generally dip only 1 or 2 degrees in the direction of normal dip; in contrast to lower rocks of the country east of Kennedy Range escarpment and north of Desert Basin escarpment, where dips of 5 degrees and upwards are common and reverse (east and north, respectively) dips are not unknown. Only in one or two instances are reverse dips (those contrary to the direction of normal dip) found in either escarpment; but reverse dips of as much as 10 degrees have been seen in some instances, and those of over 1 degree in many instances, in the lower beds east of the escarpment in Gascoyne and Lyndon Districts of Northwest Basin. Reverse dips of greater angle are reported in Fitzroy Valley by Messrs. Talbot and Blatchford in unpublished private reports, and by other geologists in informal verbal communications.

8. The characteristic colour of the beds in the escarpments is white (except where ferruginous beds have been reddened owing to oxidation), whereas the lower series of sandstones and limestones appears to be almost any shade of gray, but seldom white throughout any considerable thickness.

9. No limestones or shales are known in either escarpment, but thin shales and great thicknesses of limestone, as well as of sandstone, abound in the lower land to the east (in Northwest Basin) and north (in Desert Basin).

10. Instead of being uniformly devoid of fossils, like the sandy escarpment beds throughout hundreds of feet vertically, the lower calcareous strata abound with fossils.

Distribution of Jurassic strata.

On the published geological map, an area of Jurassic rocks is represented in western Desert Basin. It includes a small patch near Derby, nearly the whole of the peninsula west of King Sound, and a belt along the coast that has a diminishing breadth of from 40 miles near Broome to nothing at Wollal. In Northwest Division the Jurassic system consists of a belt of variable width extending south from Onslow, across Lyndon and Gascoyne Districts to beyond Wooramel River—the approximate southern limit of the area studied. I have no definite suggestions for additions or corrections to the map, so far as Northwest Basin is concerned; although I have an impression that a narrow belt of Permo-Carboniferous rocks may possibly be traceable from Yannerie River (the farthest point north at which it has been reported and mapped) to Ashburton River and thence somewhat east of that river to the coast.

In Desert Basin some suggestions may be of value. As stated by Gibb Maitland (op. cit., p. 41), Jurassic rocks "'may extend some distance into the Interior" east of Ninety Mile Beach. The Jurassics are not continuous, evidenced by the discovery of probable Permo-Carboniferous fossils in the characteristic glazed red conglomeratic sandstone on Anna Plains Station, the frequent occurrence of this rock north to beyond Lagrange, and the discovery of abundant Permo-Carboniferous (?) fossils in similar rock near Camp 12, west of McLarty Hills, as described in this paper.

The identification of Jurassic strata in western Desert Basin is largely dependent on the discovery by Gibb Maitland (*loc. cit.*) of *Belemnites* 1,300 feet below the surface in bore No. 2 at Broome. The mapped extensions of Jurassic north and south of Broome are doubtless based largely on the occurrence of certain outcrops—similar to those at Pt. Gantheaume and Entrance Point near Broome—along the coast at widely separated localities, viz., at Cape Borda (according to a verbal report made to me by a geologist who visited it) and Cape Villaret, 25 miles southwest of Broome. The predominant rocks at these localities are fine-grained white sandstones in which small flakes of mica are prominent.

At Pt. Gantheaume, 4½ miles west of Broome (Plate xviii, fig. 2), the outcrops beneath the laterite covering, in cliffs 60 feet high, consist of fine to medium grained, somewhat micaceous sandstone, cross-bedded to regularly bedded, in which the dip averages 1 to 2 degrees in a direction S. 60° W. At Entrance Point, somewhat nearer Broome, in cliffs 30 feet high, the strata are similar, light gray to white, hard to soft, regularly bedded sandstones. At the south end of Cable Beach, 3 miles north of Pt. Gantheaume, underneath laterite deposits, are a few outcrops of white, micaceous, fine to medium grained, regularly bedded sandstone, flat or dipping very slightly southwest. Mica flakes are also abundant in white sandstone thrown out of Hamilton's well, 42 miles southeast of Broome, but the rock in other respects resembles that of the Plateau escarpment.

At Cape Villaret, 25 miles southwest of Broome, the 70 foot cliffs consist in part of Recent consolidated sand-dunes (Plate xvi, fig. 2), but in other portions they are fine-grained, white or oxidized, hard sandstone, with some coarse sandstone layers, some thin bands of which contain mica flakes and some hematitic beds, weathered into fantastic forms and surface hardened as usual (Plate xviii, fig. 1). Coarse, white, unoxidized sandstones are interbedded with the fine-grained beds. The dip averages 1½ degrees in a direction N. 15° W.

Cape Villaret is the last coastal outcrop to the south at which I saw characteristic Jurassic material in Desert Basin; but Mt. Phire, 15 miles east of Anna

Plains Homestead, and 50 miles south of Lagrange, I found to be an unmapped table-top group of five hills (Plate xvi, fig. 3), distributed over 2 square miles, supplemented by an isolated hill 2 miles farther east. These hills are interesting physiographically, being the only known summits north of Callawa Hills (see herein below) that stand above the regular level of the "pindan sands," except an isolated tower-like hill with steep sides visible from Mt. Phire in the far distance and estimated 30 miles N. 35° E. The height of the Mt. Phire group is estimated at 100 to 130 feet above the low plain. The hills are capped by fine-grained white micaceous sandstone and hard semi-porcellanitic material alternating with, or underlain by softer chalky beds. The dip is 1½ degrees in a direction N. 65° W. The upper 10 to 30 feet consists in places of red massive sandstone, resting with very slight unconformity on finer grained beds (Plate xvii, fig. 1).

Owing to the rough regularity in height of table-tops (Pt. Gantheaume, Capes Borda and Villaret, Mt. Phire and the unvisited peak to the northeast), all 70 to 130 feet above other outcrops, and the presence of these rocks lying practically flat within a few miles of the Broome bore in which Jurassic fossils were found, they all appear to be of probable Jurassic age. Other outliers, similar to Mt. Phire and the unvisited peak, may be dotted over the southwest part of Desert Basin, but they are as yet undiscovered.

Probable Jurassic extension south of Desert Basin.

Near the 121st meridian west of Oakover River, stands a persistent tableland that has been traced from near the junction of Oakover and Nullagine Rivers south to Braeside Station and thence seen to extend out of sight far to the southward. Although only a few miles in breadth, it rises from the valleys abruptly 100 to 120 feet, is capped by hard, white, frequently opalescent quartzite, often over 30 feet thick, and generally lies nearly flat.

This tableland is doubtless the one mentioned by Gibb Maitland (op. cit., p. 47) as occurring near Carawine Pool and suspected by him of being Tertiary; but in conversation he admits that its age may be Jurassic, as the evidence seems to be absent. On my traverse south from near the junction of Oakover and Nullagine Rivers, this tableland was paralleled almost continuously, and glimpses of it were also obtained far to the north, where it enters Desert Basin and is apparently continuous with Callawa Hills. The last-mentioned have not been visited by me, but their near continuity and similar topography are worthy of note. A reasonable assumption is that Callawa Hills may be of identical age with Mt. Phire, which is similar topographically; and if this correlation be true, the age of the tableland of the Nullagine-Oakover divide is also probably Jurassic. Whether or not this be so, the tableland of the Nullagine-Oakover divide constitutes an outlier of Desert Basin rocks resting on Nullagine and older rocks south of the Basin proper.

Braeside (tillite) formation.

Less than a mile east of the tableland above described, between it and Oakover River, and situated 2 miles north of Braeside Homestead, more than 100 feet below the tableland and intermediate between it and the valley bottom, I found an unrecorded tillite deposit. It forms gentle slopes throughout an area of perhaps 100 acres and consists of soft, light gray, granular, siliceous and aluminous material capped by a thin bed of harder coarse conglomerate. The white material is filled with erratic pebbles of granite, gneiss, quartz, sandstone, shale, schist, etc.,

but none of the peculiar opalescent quartzite from the tableland to the west was found in it. The pebbles are frequently finely striated, and are in size up to a foot in diameter. Some are rotten, owing to weathering, although the surface of an individual pebble appears very fresh.

My impression is that this tillite is of pre-Jurassic age, reasoning from its topographic position with reference to the tableland, and also from the fact that no pebbles of Jurassic (?) quartzite were found in it. Otherwise it might be supposed equivalent to the Wilkinson Range beds of tillite found by Talbot in Princess Range, near Lake Carnegie, 350 miles south, and provisionally assigned by him to the Cretaceous system.* If the tableland of the Oakover-Nullagine divide be of Tertiary age, as was originally suspected by Gibb Maitland, the Braeside tillite may be of Cretaceous age; otherwise it is probably Permo-Carboniferous, constituting the first discovery of Permo-Carboniferous tillite on the south flank of Desert Basin. The difficulty of accepting a Permo-Carboniferous age lies in its quite different character from the very coarse, relatively dark Lyons conglomerate of Northwest Basin; but, as has been well said, "lithologic character is no criterion for the age of a tillite."

The tablelands and their significance.

The common designation "Great Plateau of Western Australia" seems, to a stranger in the country, to be too generalized and often used loosely. Of course, in ascending the north escarpment in Kimberley Division at any one of many points, and travelling along it or across it for hundreds of miles at never less than 700 feet above sea-level, as has frequently been done farther east, one feels unconsciously that the Plateau is a unit. But, as was learned on the recent trip in travelling south from the escarpment, the plain slopes south from this elevation to roughly 300 feet above sea-level in inter-ridge valleys near the Fiftieth sand-ridge, 40 miles or so south of the escarpment and 170 miles more or less southeast of Broome. The occurrence of supposed Permo-Carboniferous fossils in these valleys 185 miles southeast of Broome and estimated 130 miles eastsoutheast of Anna Plains Station is some index of the age of the beds forming the Plateau; but the fact that Cape Villaret and Mt. Phire rise 70 and 130 feet respectively above the coastal Permo-Carboniferous (?) plain (Plate xvi, fig. 3) establishes them as remnants of a higher Plateau, the beds of which are probably of Jurassic age. It is this last-mentioned Plateau that may once have been continuous with that of Callawa Hills and the tableland of the Oakover-Nullagine divide. The two plateaus—a widespread one composed of Permo-Carboniferous strata and probably Tertiary peneplanation, and a more fragmentary one composed of Jurassic beds—should be carefully differentiated in any consideration of the physiography of northwest Western Australia.

Some facts may seem to warrant the assumption that the sandstones of the north Plateau escarpment, and hence those of the great central portion of Desert Basin, are of Jurassic age, instead of Permo-Carboniferous; but Mr. Dun's opinion that the fossils from Camp 12, 185 miles southeast from Broome, are probably Permo-Carboniferous, does not substantiate this view; hence we can continue to consider the north Plateau escarpment and the centre of Desert Basin to be Permo-Carboniferous as mapped.

* Talbot, H. W. B.: *Geol. Survey W. Aust.*, Bull. 83, 1920, pp. 59-60, fig. 16 and frontispiece.

Turning now to Northwest Basin, there is positive evidence (in the form of fossils collected by Gibb Maitland from Trig. Station K37, on top of the south end of Kennedy Range) that this range, together with Carrandibby and Moogooloo Ranges, is of Permo-Carboniferous age; and, since these hills have roughly an altitude of 1,000 feet above sea-level, they should be considered contemporaneous with the north Plateau escarpment.

Near Winning Pool, southeast of Exmouth Gulf, some white, chalk-like hills, 50 to 100 feet high, have an east-facing escarpment and are mapped as Jurassic. These perhaps may be correlated with the outliers of supposed Jurassic age in western and southern Desert Basin; although in character they resemble the north Plateau escarpment and some beds in a ravine west of Wanganut well between Broome and Beagle Bay (southwest of the outcrops described hereinabove as Permo-Carboniferous). Higher outliers a few miles southeast of Winning Pool have not been visited. Far to the west of Winning Pool, on Giralia and Bullera and west of Exmouth Gulf, widespread folding of probable Tertiary age has occurred, so that Tertiary sediments are much higher in elevation than are any of the tablelands mentioned.

Distribution of Tertiary and Post-Tertiary strata.

The Tertiary strata of Northwest and Kimberley Divisions have received little attention. Some of the outcrops of low-lying limestones and calcareous sandstones along the coast are undoubtedly Quaternary and Recent. Careful study of the narrow coastal belt mapped as Tertiary and Post-Tertiary between Roeburne and Broome might lead to interesting differentiations. My own observations include the following:

1. Unconsolidated sand-dunes and sand-ridges.—These are the most recent formation in Western Australia and are still being deposited, not only on the coast (Plate xvi, fig. 1) but also over large areas in the interior. In my traverse south from the north Plateau escarpment, eighty-five of these sand-ridges were crossed, each one constituting an entity, very persistent, and few of them having any ascertained termination. Their trend varies with few exceptions between S. 75° W. and N. 75° W.; they range from a few feet to 60 feet in height, measured from the base of sharp ascent, but are much higher if referred to the centre of the inter-ridge valleys. The width of the ridges varies from 150 to 1,500 feet, and they are often composite, rough and hilly, with several crests. Most of them are covered with a growth of hummocky spinifex, but they have a greater proportion of sand than spinifex surface, and they support a few trees, as do also the valleys between them.

The most interesting features of these sand-ridges are their great persistence, regularity of trend, and the fact that the valleys between them are only slightly encumbered with deep sand, so that an ordinary motor car, once arrived between any two of the ridges, could travel for long distances between them, by jolting over the spinifex clumps that are rarely absent from any square rod of surface. Little possibility exists of a motor car crossing these sand-ridges without special appliances for the wheels, which sink deep into the sand, but caterpillar tractors can cross them if well supplied with petrol, water and spare parts.

The sand-ridges are not only present in the interior of the Plateau, but they strike the coast throughout a belt roughly 70 miles wide between Wollal and Pardu Homesteads and render motor travel along the main north-south road very difficult. In Northwest Basin similar sand-ridges rest on top of Kennedy Range (Plate xix,

fig. 1) and they form high barriers to the good grazing country west of Exmouth Gulf.

2. Sea-level plains, including Roebuck, Anna and other Plains, at sea-level or within 5 feet of high water mark.—These are formed of silt and are saliferous and full of Recent marine shells. In the country north of Broome, dead cajiput trees, on and behind these plains, signify that the land is now sinking. The plains extend at times as much as 30 miles inland from the coast, fringed and backed by "pindan sands." The sea-level plains appear to be, next to unconsolidated sand-dunes, the most recent formation of southern Kimberley Division. The following Post-Tertiary species have been identified by Mr. W. S. Dun from collections by me near Coolmakop well, 10 miles southwest of Male Station, on the southeast edge of Roebuck Plains, 30 miles southeast of Broome:

Post-Tertiary species collected on Roebuck Plains.

Arenlaria venuste Dunke.
Cassidula angulifera Petit.
Cerithoidea obtusa Wood.
Cerithoidea kieneri.
Ellobium auris-judie Linn.
Melampus flexuosus (?).
Plectotrema sp. (?).
Arenlaria optima.
Melaraphe scabra Linn.
Nerita albicilla Linn.
Pyrazus fluviatilis.
Corbula crassa Hinds.
Arca granosa Linn., var. *cuniata* Reeve.
Pupoides pacificus Pfeiffer.
Succinea operta Cox.
Succinea scalarina Pfeiffer.

3. Consolidated sand-dunes.—Not necessarily older in every instance than the unconsolidated sand-dunes, yet consolidated to the consistency of sandstone; sometimes cut by the sea waves and forming vertical sections 10 to 70 feet high on the coast from Broome southward. The cross-bedding and typical dune formation are illustrated in Plate xvi, fig. 2.

4. "Coquina" or shell rock.—Deposits of shells, 20 feet in thickness, extending to that height above high water mark near Kamelin Pool, and lower deposits of shell rock on the coast at Port Hedland and Broome.

5. Raised sea-beaches.—These consist of sandstone, limestone or comminuted masses of shells and sand-grains. Raised beaches have been seen at frequent intervals from Port Hedland to Lagrange, and they sometimes rise 50 feet above tide level. In topography they take the form of beach-like belts sometimes paralleling the coast for many miles. The surface of these beds is frequently considerably hardened and the outcrop has a concentric pseudo-folded appearance. The best exposures were seen 2 miles southwest of the southwest end of Ninety Mile Beach on Pardu Station, where a ragged limestone outcrop, 50 feet high, composed of shelly calcareous sandstone, forms the coast for a mile or two. At Port Hedland similar outcrops rise 10 to 15 feet above high tide.

If the dead trees surrounding the sea-level plains north of Broome indicate a sinking of that part of the coast at the present time, the raised beaches indicate a recent rising of the coasts in the area from Lagrange southward. The pivot appears to be not far from Broome.

6. A zone of red soil.—This has been seen in a few localities near Broome and is exposed a few feet in thickness underneath the "petrified" coastal sand-dunes at Cape Villaret. The red soils are Recent or Quaternary in age.

7. "Pindan sands."—Practically all of the country round Broome, with the exception of the sea-level plains and the small areas of rock, is known as the "pindan sands." Such areas consist of level to gently rising unconsolidated sands, often rising to several hundred feet above sea-level at distances from the coast, and in general sloping upwards against older formations. The "pindan sands" are generally covered with a thick growth of shrubs or low trees of many varieties, known collectively as "pindan." These sands are probably of various ages from Permo-Carboniferous to Recent, and can not be differentiated until enough wells are sunk in them so that fossils shall have been found and determined at widespread localities.

The "pindan sands" cover nearly the whole of the peninsula west of King Sound, most of the country east of Broome, north and south of the Derby road, and extend southeast from Broome from the inner edge of Roebuck Plains to a distance of over 100 miles and beyond that until they merge with the sand-ridge country of the semi-desert; and they also occupy the inter-sand-ridge spaces. Most of the country from Broome south to Port Hedland that is not a sea-level plain is a part of the "pindan sands"; and in fact the term is doubtless applicable much farther south, except that the word "pindan" is apparently limited to the North.

The "Cape Range" formation.

The most unexpected discovery of any relative to the Tertiary system was in the "Cape Range," extending south from Northwest Cape, where white limestones and interstratified chalky beds form a great anticline rising from below sea-level on the west side of Exmouth Gulf to a height of over 1,000 feet in the centre of the Range (Fig. 4), intersected by deep gorges extending back miles into it. Some beds of the chalky material are full of foraminifera, as yet unidentified, and only surmised to be of Tertiary age.* The east dips vary from nil on top of the Range to 8 degrees on the lower east flank (Plate xvii, fig. 2). Far up a gorge in the Range, at a point 15 miles south of Northwest Cape, I saw the dips flatten out and then dip toward the west at an angle of 2 degrees; but the gorge was not followed farther west. Rocks are also reported to dip sea-wards at Pt. Cloates, 75 miles south of Northwest Cape, on the west side of the Range.

I infer that the Range is an anticline, because, firstly, west dips of 2 degrees were actually observed along a line not far from the centre of the mountain range; and secondly, if the Range were a monocline it would imply a shore line to the west, which has not been proved or even suspected. East of the anticline of Cape Range other anticlines were found, one of which, on Giralia Station, 20 miles east of Cape Range, has a height of at least 300 feet and a breadth of 10 miles.

For the strata that comprise these anticlines and form the surface between them, I suggest the name "Cape Range" formation. The foraminifera have not yet been determined, but it seems probable that they will show a Tertiary age.

* *Note*, 29th March, 1925.—Word has just been received from Professor Sir T. W. E. David that Mr. F. Chapman states emphatically that these foraminifera are Oligocene types of *Lepidocyclina* and *Cycloclypeus*. The above is therefore an important discovery of raised and flexed Oligocene limestones in Western Australia.—Ed.

Large areas along the coast and for some miles back from it between Northwest Cape and Hamelin Pool may be part of the same formation.

Country east of Onslow.

An interesting section, 7 miles in breadth, of some of the very old rocks, exists in the interval from about 35 to about 42 miles east from Onslow. More or less continuous outcrops were passed on a northeast-southwest traverse, all dipping at an average angle of 20 degrees in a direction S. 60° E. Thus, the strata, if not duplicated by unseen faults, appear to be perhaps 13,000 feet in total thickness. They consist of rather uniform, hard, light gray, thick-bedded quartzites, with some medium-grained sandstone and traces of softer white material below the hard surface.

Although this belt of outcrops appears to lie on the strike of the Mosquito Creek beds (pre-Cambrian) mapped less than 100 miles to the south, the rocks are perhaps similar in character to some of the Permo-Carboniferous rocks when surface-hardened. The locality was not observed to be cut by quartz veins or by granite, like the Mosquito Creek beds seen elsewhere; and the only intrusion noticed was a large dyke of basalt, apparently occupying the centre of an anticlinal fold just west of Peedamullah Homestead.

Similar gray quartzites of similarly great thickness, seen in the area between Nanutarra and Uaroo Homesteads, south of Ashburton River, are underlain by at least 2,000 feet of schists. The formation south of Nanutarra is folded into several great anticlines, in the centre of which valleys have been eroded; but in that area the quartzites and schists are intruded by innumerable quartz veins, granites and gneisses, so that here, as in the De Grey River country, certain granites can be proved younger than certain sedimentaries.

Conclusion.

The matters discussed in this paper constitute merely a few of the problems existing in the northwest of Western Australia. Other problems are (1) Climatic factors in geological history, (2) Number of glacial periods, (3) Unity or multiplicity of the northwestern laterites, (4) Question of faulting on the east side of Northwest Basin, (5) Ages of folding in Kimberley Division, east side of Northwest Basin and west edge of Northwest Basin, (6) Water problem in Desert Basin, (7) Origin of certain saline waters, (8) Climatic factors in human history, and many others that apply to that part of the Commonwealth. A vast field exists for geological work; the importance of the work to the future welfare of the State and the Commonwealth is very great, in addition to the benefits to be derived by science from such investigations.

In conclusion I want to express my obligation to Mr. A. E. Broué for permission to make the facts and theories in this paper available to geologists. I also wish to thank Prof. Sir T. W. Edgeworth David for valuable advice on stratigraphical matters, Mr. W. S. Dun for final determination of fossil species, and Mr. A. Gibb Maitland for counsel and general advice as to methods of approaching the field and problems.

EXPLANATION OF PLATES XVI—XIX.

Plate xvi.

1. Typical sand-dunes near Broome.
2. Wave cut cliff of consolidated sand-dunes at Cape Villaret.
3. Mt. Phire—an outlying table-land of Jurassic age.

Plate xvii.

1. Formations constituting Mt. Phire.
2. East dips in Cape Range, west of Exmouth Gulf.

Plate xviii.

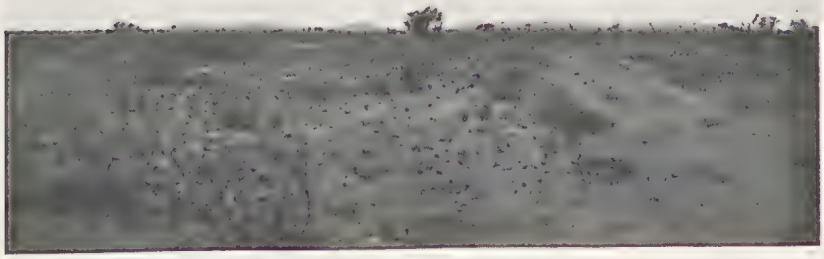
1. Surface hardening in sandstone of Jurassic age at Cape Villaret.
2. Sandstone of probable Jurassic age, Gantheaume Pt.

Plate xix.

1. View of top of Kennedy Range, site of Merlingleigh Homestead.
2. Lyons Conglomerate (tillite) east of Gascoyne Junction.
3. Dips on east flank of dome on southwest Williambury Station, Northwest Basin.

1

2



3

1. Typical sand dunes near Broome, Desert Basin.
2. Wave-cut cliff of "petrified" sand dunes that rest unconformably on Jurassic (?) sandstone, Cape Villaret, Desert Basin.
3. Mt. Phire—an outlying tableland of probable Jurassic age, 15 miles east of Anna Plains Homestead, Desert Basin.

1. Coarse ferruginous sandstone resting with slight unconformity on white semiporcellanite beds, dipping gently seawards; top of Mt. Phire, Desert Basin.

2. East dips in gorge on east side of Cape Range, 15 miles south of Northwest Cape. The rock is probably Tertiary in age.

1. Caps caused by surface hardening in finegrained white sandstone of probable Jurassic age, Cape Villaret, Desert Basin.

2. Finegrained white sandstone of probable Jurassic age, dipping gently seawards, Gantheaume Pt., near Broome, Desert Basin.

1

2

3

1. Vegetation and sandhills at site of Merlingleigh Homestead; summit of Kennedy Range, near north end.
2. Common phase of the Lyons Conglomerate, east of Gascoyne Junction.
3. East (abnormal) dips on east flank of dome 14 miles west of Moogoorie Homestead. The central valley at right of escarpment is occupied by an up-fold of Lyons Conglomerate, 9 miles west of its normal outcrop.

THE GEOLOGY AND PETROGRAPHY OF THE CLARENCETOWN-PATERSON DISTRICT.

Part iii. A Study of the Main Glacial Beds at Seaham.

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(Plate xiii; 1 Text-figure.)

[Read 25th March, 1925.]

Introductory.

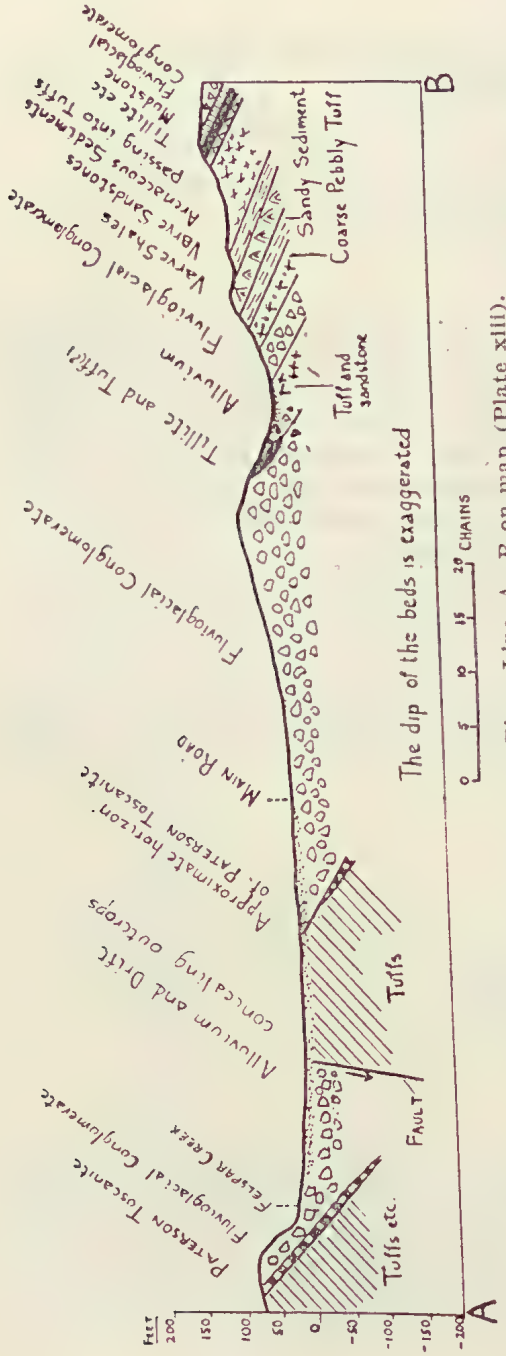
In the account of the stratigraphy of the Kuttung Series in the Clarencetown-Paterson district (Osborne, 1922) it was pointed out that, although difficult to classify satisfactorily, the Kuttung Series, in this, the type, area, showed a more or less well-marked threefold division into the Basal, Volcanic and Glacial Stages. The last of these was subdivided into a Lower Portion and the Main Glacial Beds, these two being separated by the dellenite-toscanite lava (Paterson type), which was found to occupy a constant stratigraphical horizon throughout the area. In the Lower Portion there occurs a definite band of varve rock, as well as a great thickness of arenaceous sediments, but in the Main Glacial Beds we have an assemblage of rocks which show unmistakable evidence of the existence of a pronounced glaciation during the period of their accumulation.

The best locality in the Lower Hunter Valley to study the Main Glacial Beds is at the village of Seaham and in its immediate neighbourhood. This was recognised by C. A. Sussmilch who described some features of them in 1919 (Sussmilch and David, 1919), giving the following section:—

	Feet.
Grey tuffaceous mudstones	264
Tillite Bed (No. 5 Bed)	75
Varve Shales	100
Tillite Bed (No. 4 Bed)	80
White Tuffs	55
Tillite Bed (No. 3 Bed)	200
White Tuffs	315
Varve Shales (with contortions)	110
Fluvio-glacial conglomerate (No. 2 Bed)	50
Tuffs (with conglomerates)	220
Fluvio-glacial conglomerate (No. 1 Bed)	270
Total	1,739

The above section, however, gives only the broad features of the succession. In addition to the statement of the sequence, Sussmilch described certain of the units in some detail. Subsequent to this account, the present writer wrote something upon the distribution of the various units in the Glacial Stage (*loc. cit.* pp. 193-4), but nothing of a detailed nature was published. Later, in 1922, when visiting Seaham, it was noticed that excavations in connection with the construc-

tion of the Pipe Line from the Chichester Dam to Newcastle had exposed a very interesting section of the rocks, and it was decided to measure the section while the cuttings were fresh, and complete the detailed study of the beds. The present paper is the outcome of this work, together with certain observations made during the main survey in 1921.



Text-fig. 1.—Section along Pipe Line, A—B on map (Plate xiii).

SEQUENCE OF THE MAIN GLACIAL BEDS.

Every horizon of any importance was traversed in the field and the Map (Plate xiii) is the outcome of this survey. Along the Pipe Line, A—B, the section indicated in Text-fig. 1 is to be found. (Unfortunately as a result of weathering, soil creep, etc., the section at the present time is much obscured in contrast with its original appearance.)

Beginning at the main road just beyond (to the north of) its crossing of Felspar Creek, the Paterson toscanite dips to the south. This is overlain by a notable fluvio-glacial conglomerate, the salient features of which have been given by Mr. Sussmilch. In this unit there is a band of gravel differing markedly from the rest of the deposit, in that there is a greater continuity of bedding, and an approach to uniformity in the size of the pebbles. It also possesses a characteristic property connected with the cementing material, the pebbles being coated with a film, purplish in colour, and probably composed of some compound containing manganese.

These features made this horizon of distinct stratigraphical value in helping to determine the position of a fault in the area.

The fluvio-glacial conglomerates occur sporadically through the alluvium of Felspar Creek, but are stopped by a fault which seems to throw them against the tuffaceous sandstones under the Paterson toscanite. These sandstones can be found forming the base of the hills immediately to the south of Felspar Creek, on the west side of the main road. The

Paterson flow, overlying the tuffaceous sandstones, is difficult to find on account of the heavy mantle of talus material and also because of its small thickness hereabouts. It does not outcrop in the Pipe Line cutting, which here is shallow, but, as will be seen on the map, it occurs both to the west and east of the section. Continuing along the section the conglomerate, with its distinctive pebble band, follows the toscanite. A little to the west of the Pipe Line the outcrop of these fluvio-glacial conglomerates comprises a number of large boulders derived from the underlying igneous rock, which on disintegrating, are apt to be mistaken for outcrops of the lava *in situ*. On these hills to the west of the main road there is an abundance of pebbles showing faint glacial striae.

Following the conglomerate comes an extremely hard rock consisting of angular fragments set in a matrix. This combines some of the features of a tuff with those of a tillite, and there is no doubt in the writer's mind that it is glacial in origin, at least in part. Continuing south, a small creek is crossed, and there then follows a coarse tuff which varies in texture from place to place. The dip on these beds is S 20° W at 8°. Overlying the tuffs comes the second definite bed of fluvio-glacial conglomerate. This unit contains many faintly scratched pebbles and outcrops well to the east. Following it are some interesting rocks which seem to be coarse glacial sediments mixed with tuff. The lower portion of these beds is composed of pebbly material, and this passes into finer sediment and then into a zone of transition to the overlying varve-rock. This zone of transition possesses some beautiful contortions in which the fine material is intimately mixed with the arenaceous sediment.

The varve-rocks now succeeding constitute the main horizon of these in the district. They show evidence of contemporaneous contortion and of local minor dislocations. They are overlain by sandy sediments showing, in places, evidences of seasonal deposition and may be called "varve sandstones". The textures in these rocks comprise three distinct degrees, the grainsize increasing towards the top, where the rocks are undoubtedly mixed with some tuff.

Summarising the section thus far we have (*see* Text-fig. 1):

	Thickness in Feet.
Fluvio-glacial Conglomerate (Felspar Creek horizon)	420
Felspar Creek Tillite	10
Acid Tuff (?)	50
Fluvio-glacial Conglomerate with local tillitic masses	40
Coarse Tuff with pebbles	50
White sandy sediment with transition to overlying varve rock	100
Main Fine-grained Varve Rock	100
Fine Sandy Sediment (Varve Sandstone)	80
Fine-grained Sediments	100
Coarse Tuff	70
Total	1,020

Overlying the coarse tuff comes a series of layers composed of both tillitic material and glacial mudstones, some showing varve structures and indications of having been strongly contorted before consolidation. These layers are present in the following order, ascending stratigraphically:

	Feet.
Limonitic contorted varve rock	2
Hard calcareous tillite	1½
Tillite and purple varve rock	3
Grey mudstones	5
Total	11½

The above rocks include the most definite tillite occurring in the whole district.

The sequence after this point is not clearly defined, chiefly owing to the intermittent nature of the outcrops and the lack of persistence of the units. But the general features are as follows: The tillite material is followed by glacial mudstone in which one notable erratic of granite occurs. This underlies a definite fluvio-glacial conglomerate which has been referred to by Mr. Sussmilch as No. 3 Bed. Overlying this, just to the south of the Maitland road, are a number of units comprising tillite, agglomerate and mudstone, while in a similar position to the east is the second unit of fine varve rock.

Tuffs now succeed the rocks just mentioned and also a fifth band of tillite, this being followed by a slate-blue rock, fine-grained and calcareous, which is extremely tough and resistant to weathering. In the centre of this unit there is a less competent portion, not unlike the varve rocks in many respects. Succeeding this horizon comes a drab-coloured mudstone, sometimes banded and locally conglomeratic, which ends under a distinctive conglomerate with tuff bands, which has been regarded by Sussmilch as being the basal unit in the Permian or Permo-Carboniferous System for this district. Certainly this unit seems to differ in general facies from the conglomerates of the Kuttung Series, and it is clear that its horizon is very close to the junction line of the two systems, for, at a very short distance to the south (i.e. in the direction of dip), there occurs decomposed basalt which the writer thinks belongs to the Lower Marine Stage of the Permian System. It would appear that this conglomerate, if Permo-Carboniferous in age, has overlapped some of the older members of the Lower Marine Series, such as the Lochinvar shales, etc.

Thus a generalised section of the rocks following the end point of the Pipe Line section is as follows:

	Feet.
Mudstones with erratics	100
Fluvio-glacial conglomerate	200
Tuffs and agglomerate	50
Tillite	60
Varve rock (second horizon)	100
Tuffs	80
Tillitic rock	50
Fine-grained calcareous rock	50
Drab-coloured mudstone	180
Total	870

The total thickness, therefore, of the glacial beds indicated in the sections described above is 1,890 feet.

Concise Account of the Distribution of the Main Glacial Beds.

The most complete sections have been measured along the Pipe Line and to the south of the turn in the Maitland road near the cemetery, but a consideration of the distribution of the various beds gives some interesting information. The present description can only be brief.

The basal member of the series, the Felspar Creek conglomerate, is well developed on the left bank of Felspar Creek near its confluence with the Williams River and again, as a result of the fault, on the hills to the west of the main road a little to the north of the hotel. Also, in the paddocks of the Porphyry Estate, the boulders from the tillitic mass are very conspicuous. To the west-north-west of the hotel, in the upper portion of a small creek, there is a large

mass of tuff developed on the top of the Felspar Creek conglomerate. This tuff is pebbly in places. The angular-fragmental rock occurring on the Pipe Line appears to be restricted, but the succeeding tillitic conglomerate, on which the Post Office stands, is fairly persistent. The main varve-rock horizon extends uninterruptedly from the Raymond Terrace road to the western margin of the region mapped, and the rocks show the usual varve structures and contortion zones until one comes to a spot, marked with a cross on the map, where a zone of brecciation or disturbance is found at the top of the rocks; a somewhat similar set of features occurs near the main road a little above the hotel. These structures will be described in detail later.

The interesting arenaceous rocks and coarse tuffs following the varve rock go across the village in good development. The zone of tillite and contorted shale which is found just at the end of the Pipe Line section overlying the coarse tuffs, contains a band of purple material which can be traced as shown on the map. South from the main road there is a lack of persistence of units and irregular masses of tillite, tuff, conglomerate, and mudstone are associated in haphazard fashion. Some of these tillitic units seem to be in much the same position as they were originally, when dumped by glaciers, not having suffered subsequent sorting by water action as did much of the sediment in the district.

The restricted outcrop of the second horizon of varve rock, on the Raymond Terrace road and in the cemetery, suggests that they were developed in isolated basins, between which were dumped masses of till, etc. One or two of the horizons succeeding the second unit of varve rock are well developed and show out quite well physiographically.

Structure of the Area.

The structure of the area under consideration is quite simple. The rocks show a general dip towards the south, the values of reliable dips showing that there is slight rolling in the strata. Near Felspar Creek the dip has been measured, approximately only, at 15° in a southerly direction, while the lower varve rock gives reliable dips of S. 12° W. at 30°, and S. 14° W. at 12° at the main quarry and near the Pipe Line respectively. It might be mentioned here that dips upon varve rock can only be regarded as reliable when measured upon exposures such as are afforded by fairly large quarries or recently eroded creek banks where creep and minor dislocations can be proved absent.

The east and west alignment of the rocks forms the nose or front of the flatly-arched plunging anticline which, in a former paper, was described as the Williams River anticline. In addition to minor dislocations there is one important fault. It is a strike fault, and its probable position is shown on the map. The duplication of some of the beds, bringing about the adjacency of rocks which are separated by an appreciable stratigraphical interval and, to a small extent, the physiographic features comprise the evidence for the existence of the fault. Thus the Paterson toscanite has been found on both sides of Felspar Creek which flows parallel to its strike. In fact, the repetition of the lava to the south of the creek, in the first place, formed the key to the structural features, and it was because of the difficulty of locating the southern outcrop of the toscanite (as has been indicated above) that the fault was not apparent during the former, less detailed, survey of the Seaham district.

The fault is normal, and has an estimated throw of 450 feet, assuming, as is probable, that it dips steeply. It is interesting to note that there is no clear sign

of the fault crossing the Williams River, since the toscanite and associated lavas do not appear to be duplicated to the east of Porphyry Point. However, the locality where one would expect to find the faulted outcrop of the Paterson lavas is given over to swamps and heavy alluvium, which would obscure the structural features. If the fault does not cross the river it is possible either that it dies out towards the east or, turning in its trend, joins up with the large fault which runs along the Williams River north from Raymond Terrace towards the east of Mt. Gilmore.

Lithology and Petrography.

A considerable amount of time has been spent in the petrological examination of these glacial beds. The majority of the horizons have been studied with the microscope, but in some cases the megascopic features only have been noted. In the following discussion the rocks will be taken in ascending stratigraphical order as far as is practicable. It should be pointed out that the truly igneous rocks, e.g., the tuffs and patches of agglomerate, will not be considered in much detail, as they will be included in the chapter on the petrography of the Kuttung Series which is now in preparation. The numbers cited refer to the specimens in the writer's collection.

The lithology of the Felspar Creek conglomerates is interesting. The boulders consist of a large variety of acidic types of igneous rocks with subordinate numbers of fine metamorphic and sedimentary rocks, quartzites being predominant among these. C. A. Sussmilch has described certain features of this horizon: while much of it is fluvio-glacial, there are portions which consist of almost true tillite. *Specimen 463* of this rock, collected from the Pipe Line, shows, under the microscope, the presence of volcanic fragments, altered orthoclase and a little plagioclase set in fine matrix. Among the volcanic fragments there are some almost holohyaline rocks, in which banding and flow structure are conspicuous. Along some of the bands, haematite has separated by a process of devitrification. Microlitic felspar and some secondary silica are also present.

Quite a number of volcanic inclusions have features which suggest cognate origin. They do not remind one of the underlying lavas in the Kuttung Series. In one or two fragments complete devitrification has occurred, while carbonation has developed throughout many of the rocks.

The felspar fragments are not very abundant, the orthoclase being either kaolinised or replaced by calcite. Plagioclase is rare and its composition is a matter of doubt. The quartz is extremely angular in most cases, but some of it shows evidence of having been corroded. There seems to be an absence of pieces of quartz showing pseudo-inclusions of groundmass, such as is characteristic of the quartz in the acid lavas of the Volcanic Stage.

The matrix is composed of numerous patches of a dull brown material, whitish by reflected light, but under high magnification seen to be composed of calcite or, at all events, of secondary carbonates. These patches, which are very feathery in outline, probably are the result of infiltration. Associated with the carbonate material there is chlorite, and it is possible that this has developed from felspar which has been replaced.

The rest of the matrix is composed of innumerable specks of chlorite and other indeterminate material, together with a notable amount of pyrites, present in sections nearly rectangular in outline. Patches of recrystallised quartz occur in places.

Specimen 464. Locality, Pipe Line, west of the hotel.

Megascopically seen to be composed of angular and subangular fragments of felsite, porphyry and chert cemented by a hard fawn-coloured material through which are scattered numerous quartz crystals.

Microscopical characters: As in *463*, there is a prevalence of vitrophyric rock types, many of which are in process of devitrification or otherwise altered. Thus haematite may be developing along lines in a fluidal rock, or silicification or carbonation is in evidence. Some of the fragments are pieces of large banded spherulites which are kaolinised.

One specimen recalls a recrystallised shale or siliceous sediment. Secondary quartz and tiny wisps of muscovite were seen. The muscovite had evidently been developed from the cement which had formerly held the quartz grains together. Felspar chips are present, many being of fairly acid plagioclase. There is notable absence of albitised rock fragments. Similar patches of secondary carbonate, as seen in *463*, are to be seen associated with silica in the matrix. The rock is a contaminated tillite, some tuffaceous material being present.

Specimen 468. Locality, east-west road running from the main road towards the varve rock quarry.

This rock is like a sandstone at first sight, but under the microscope shows many features which are directly connected with its glacial origin. In the first place the quartz grains, which constitute the greater part of the fragments, are angular or subangular, and there is evidence of little transport. The size of the grains is fairly regular, being about 0.15 mm. in average diameter.

There is quite a large amount of felspar, both orthoclase and plagioclase. The orthoclase is not strongly kaolinised, and much of the plagioclase is albite, which does not look spongy like the secondary albite often seen in albitised rocks. There is also a little altered biotite, and many grains of dull brownish material which shows up like haematite at times, and kaolin at others.

Under the high magnification the matrix presents some interesting features. There is an extremely fine-grained mass of material which is certainly partly silica. This is besprinkled with points of calcite, muscovite, some haematite and kaolin. In addition to the silica mentioned above, there is some of secondary nature, which appears just like the quartz of silicified lavas. The silica in the former category does not look quite like quartz which has been introduced and yet hardly looks as if accumulated in its present state.

Many of the plagioclase pieces are perceptibly bent, the significance of this not being known. The rock is a glacial sandstone. This material, when showing evidence of seasonal deposition, has been called "varve sandstone."

Specimen 469. Locality, Pipe Line just above the main varve rock horizon.

Megascopically, the rock looks like a tuffaceous sandstone, possessing a white colour, weathering to fawn.

Microscopical characters: The rock shows the presence of fragments of minerals, and a few pieces of rock. The grainsize of the rock chips varies from 0.6 mm. to 1.5 mm.

The plagioclase is albite and there is more of it than orthoclase, which is somewhat kaolinised. Many of the quartz fragments are very slender in form while the majority are more equidimensional, all showing quite sharp extinction. Calcite, in ragged patches, is present in notable amount, but subsidiary pieces, more regularly bounded, are present, probably representing the replacement of angular chips of felspar. One or two pieces of the calcite show cleavage rather well.

Haematite is also abundant. Among the rock fragments, devitrified and silicified rhyolites (?) occur, some of which have been originally spherulitic. In the matrix there is much secondary silica, often found wrapping around the rock fragments, and possessing features similar to that in specimen *468*. Some chlorite is present, and also tiny pieces of felspar spherulites which have not suffered by decomposition.

Specimen 472. Locality, Pipe Line, just north of the main road, near the cemetery.

This is from the horizon of the tillite originally discovered by Professor David in 1914. The rock is grey and hard, and is composed of angular fragments, and some rounded pebbles, set in a very compact matrix which is fine-grained, and possesses many quartz grains. The rock weathers to either a yellow or purple colour, being of the latter colour at the place of original discovery at the turn in the Maitland Road.

Under the microscope, apart from the large fragments which are composed of compacted varve rock or of foreign rock types, igneous and sedimentary, there is a lot of consolidated till, too fine at times to be resolved by the microscope, but, where a little coarser, seen to be composed of angular quartz and felspar, chlorite, and secondary material, together with indeterminate constituents.

Specimen 476. Locality, Raymond Terrace road, just below the second horizon of varve rock.

In hand-specimen it is seen to be essentially a quartzose tuff. The size of the fragments varies from place to place to a small degree, the average grainsize being 2 mm.

Microscopical characters: In thin section the tuffaceous nature of the rock is apparent, although there is also a little glacial sediment. Thus one sees fragments of rocks, many of which are cognate in origin, also angular quartz grains which may have been blown out from a volcanic centre, and other subsidiary constituents. Mingled with all this material are strings of fine glacial sediment.

The rock fragments comprise devitrified rhyolites, also some silicified rocks with phenocrysts of plagioclase and altered orthoclase. In some of the rocks, structures of peculiar pattern have resulted owing to the selective replacement, by haematite, of certain constituents in various rocks. Secondary calcite is not abundant. In the matrix there is much secondary silica, some secondary muscovite, a little chlorite as well as other indeterminate constituents. The muscovite and silica, which are intimately associated, occur in finely divided state and are often found mantling the large rock fragments. All these features suggest the possibility of the mica being autogenic, due to reactions which have gone on in the clayey sediment. Some greenish silicate, probably one of the chlorite group, is present, and also in the matrix some pieces of fairly fresh spherulitic felspar.

Specimen 479.—This is the tuff associated with the tillite on the Raymond Terrace road just south of the park and overlying the second unit of varve rock. In hand-specimen it suggests a glacial origin, being similar to the highest tillite on the Pipe Line section.

Microscopical characters: Under the microscope it possesses features which stamp it definitely as glacial. Some of the material is similar to the coarser layers of the varve rock. Quartz chips, fresh acid plagioclase, and fragments of volcanic rocks are set in an exceedingly fine matrix. There are abrupt variations in the size of the fragments of rock. Some of these are haematitised.

Most of the rock types are acidic, volcanic in nature. The extremely angular nature of the quartz chips is noticeable. Orthoclase is being replaced by both albite and calcite and some pretty patterns have resulted by this dual replacement of the one grain. Elsewhere the orthoclase shows slight kaolinisation. The plagioclase is fresh albite and oligoclase. The matrix is exceedingly fine and much of it cannot be resolved by the microscope. It appears to contain a fair amount of finely divided silica.

Specimen 480. Locality, Raymond Terrace road, just at its junction with Whyten Street.

An extremely finely-textured rock which effervesces readily with acid. It possesses little variation in grainsize and is very massive. It is a sedimentary rock and shows swirl and current structures.

Microscopically, it is seen to consist of numerous chips of quartz which vary little in grainsize, and fairly fresh acid plagioclase, together with some very ragged iron-ore set in an exceedingly fine groundmass. In this matrix there occurs some silica and possibly some chlorite, but the most important constituent is calcite, and in some cases this may be replacing tiny mineral chips. The derivation of this rock is a matter of doubt, but the general facies strongly suggests a fine glacial sediment.

Specimen 492.—This is from the zone of complication between the main varve rock and the underlying tuffs just west of the road near the hotel. The rock is very pretty and shows strings of tuff, with a fairly uniform texture, seaming through the varve rock.

Microscopical characters: Under the microscope the varve-shale material is seen to be very fine, sometimes possessing banding. In it are some detached rock fragments which are distinct in nature from the pieces in the tuffs. The material of the tuff stringers is much altered by deposition of haematite, while quartz crystals are quite abundant.

A number of slides of the varve rocks have been examined. The lamination is, of course, very evident under the microscope, but often, in addition to the layers visible megascopically, there are some small bands, which can only be picked up in thin section. The coarser layers are bounded by sharp lines downward, but grade up into the following fine or winter layers. The coarser layers contain angular quartz and felspar and tiny rock fragments and much irresolvable material, while the constituents of the fine layers are almost beyond identification. Haematite is abundant in some of the coarser layers.

Interesting Structures in Certain Rocks.

Peculiar relationships between some of the varve rocks and either sandy or tuffaceous rock are to be found in many parts of the area. Near the hotel, for example, just to the west of the road, and also at a number of places further to the west, one finds specimens showing intimate co-mingling of the two units, shale and tuff or sandy sediment. At times there is a suggestion that the tuffaceous material has been injected into the varve rock, while at other times the reverse action seems to be indicated. On account of the degree to which these features are sometimes developed, one is apt to mistake some of the rocks for agglomerates. It seems best to explain some of the associations as having been brought about during the accumulation of the glacial mud and tuffaceous material.

Other structures similar to those that may be explained as just indicated, seem, as they are studied carefully, to have been produced as a result of the

dragging force of moving ice. At the place marked with a cross on the map, west of the Pipe Line, one finds brecciation in the zone of transition from the underlying varve rock to the tuffs. Layers of twisted varve rock pass into breccia bands, followed by more shale and finally massive tuff. In the breccia bands some extremely complicated relationships exist. Generally the varve material is found threading its way through the fairly sharply broken tuff, but at times a confused mass is found.

It would appear that the tuffs developed upon the fine sediments, alternations occurring at the close of the shale accumulation period. The interference by the ice movement shattered some of the tuff, which had evidently become more coherent than the underlying varve rock which, though supporting the overlying tuffs (of no great thickness) was still plastic enough to be squeezed into the fractured tuff. Thus the varve rock gives the appearance of having intruded the tuff.

Chemical Considerations.

The author carried out an analysis of a fresh portion of varve rock in order to see what bearing the results would have upon the question of the origin of the sediment. The sample was taken from a thick winter layer of compacted rock-flour, occurring in the more easterly of the two quarries at Seaham. The results are given in the table below. Along with the analysis are placed four other analyses of glacial sediments.

	1	2	3	4	5
SiO_2	78.41	53.40	56.38	61.38	52.00
Al_2O_3	9.32	15.70	17.81	15.58	16.11
Fe_2O_3	.59	—	2.56	3.52	4.69
FeO	.25	3.22	5.04	2.58	
MgO	1.72	2.62	2.80	3.12	4.10
CaO	.01	5.65	3.26	2.52	8.26
Na_2O	2.13	1.95	2.13	2.82	2.76
K_2O	4.56	3.14	1.92	2.79	1.74
H_2O+	1.74	3.14	4.30	3.99	9.64
H_2O-	.85	.18			
TiO_2	less than .01	.93	.40	.48	—
P_2O_5	.10	.27	.21	.14	
MnO	.01	.05	—	—	—
CO_2	absent	6.24	3.40	.78	—
FeS_2	—	3.64	—	—	—
SO_2	—	—	—	—	.09
SrO	—	.09	—	—	—
	99.70	100.22	100.21	99.70	99.39

Specific gravity of No. 1=2.494 at 21° C.

1. Varve Rock, Seaham, N.S.W. Anal. G. D. Osborne.
2. Laminated Slate, near Adelaide, S.A. (Mawson, 1912). Anal. W. S. Chapman.
3. Dwyka Tillite, S. Africa. Quoted by T. L. Walker (1921).
4. Ojibway Clay, North-western Quebec. Anal. T. L. Walker.
5. Stratified Glacial Clay. Quoted by M. E. Wilson (1913).

Examining the figures for the Seaham rock one is struck with the high percentage of silica. This, no doubt, is due to the fact that the glaciers worked over areas of acidic rocks, confirmation of this view being forthcoming in the results of the microscopical examination of the boulder beds associated with the varve rock. Alumina and magnesia are low, and lime is conspicuously so. But the most interesting feature of the analysis is in the values for the alkalies. These total 6.69% in a rock with nearly 80% silica. This without doubt indicates that much of the material that formed the rock, which under conditions of normal

weathering would have been leached away, has been retained as a result of the protective action of the glaciers which transported the rock-flour, which later was deposited in a lake. After allotting the requisite amount of alumina to soda and potash to form felspar molecules there is very little left. This latter would be present as kaolin, but its scarcity emphasises the undecomposed nature of the material. Consequent upon the almost complete absence of lime, one must postulate all the soda as being present in the form of albite. The microscopical evidence of the glacial beds as a whole shows the prevalence of albite among the plagioclase felspar, and thus lends support to this view.

The petrographical and chemical study of glacial sediments has not been pursued to any great extent in Australia, although the lithology of many occurrences has been written up, and one or two analyses have been made. But elsewhere a fair amount of attention has from time to time been given to this subject. It will be interesting to notice certain features in connection with the analyses quoted above. Thus it may be pointed out that in all cases there is not a great excess of the molecular proportions of alumina over those of lime, soda and potash combined (some of the lime having been allotted to CO_2). Of course one must not expect to find an absence of kaolin in all glacial clays, since the glaciers which produced the clays may have worked over areas given over to aluminous rocks, such as shales.

T. L. Walker, of Toronto University, has written upon the chemical study of conglomerates (Walker, 1921), and has examined a number of analyses of undoubted glacial rocks and also of some sediments for which a glacial origin might be suspected. He has generalised that the value of the Na_2O/K_2O ratio can be used to test the origin of a sediment, a high value indicating a probable derivation of the material by glacial action, and a low value pointing to the material having been well leached, and thus probably the result of decomposition under conditions other than glacial. He also says: "In case that material were assembled from a wide area of igneous rocks the glacial rock flour should have a composition similar to that given by Clarke as the average composition of igneous rocks. Where gathered from a field where both igneous and sedimentary types are associated the cement should lie between the average igneous and the average sedimentary rock in composition."

The present writer considers that the last paragraph could not be made of general application in connection with glacial areas, because it is highly improbable that any glacial clays possess disintegrated material from such a wide area of rocks, that the analysis of the clays could come under any of the categories mentioned, except, of course, by accident.

Then again, it seems that the validity of relying on the ratio of soda to potash is open to question, since there are many exceptions to the rule that during rock decomposition soda is always leached more readily than potash, and further, there is always the possibility of derivation of rock material from areas where potash is so dominant as to give rise to a value of less than unity for the ratio in question, even though no leaching had occurred.

Structures in Varve Rocks with reference to the Estimation of Geological Time.

Seasonally-banded glacial sediments—varve rock and varve sandstones—have, on numerous occasions, formed the subject of attempts to estimate the time taken for their accumulation. Baron De Geer and his students have done classical work

in this direction (De Geer, 1912). R. W. Sayles has contributed a very important memoir upon the subject of seasonal deposition (Sayles, 1919), and has written much that deals with the matter now being considered. As a result of his studies, it is clear that much caution is necessary before one can speak with any degree of certainty upon the duration of the time taken for a glacial deposit to accumulate.

Thus there is evidence, in deposits such as varve rocks, that the complete record is not always preserved, except in those deposits which have originated under deep-water conditions, far removed from disturbing agencies such as contemporaneous erosion or ice movement, the former of which might remove quite a big proportion of material, sweeping it away to be deposited further from the ice front. At Seaham the varve rocks show evidence of contemporaneous erosion in many places. In some cases the erosion has been extensive enough to remove inches of sediment at the place of maximum scour.

Another fact, that must be realised in connection with the estimation of time by the counting of layers, is the possibility of rhythms other than the annual one making their presence felt. It is probable that the effects of daily rhythms may be strong enough to be perceptible, at least under the microscope.

Then again it has been found that material which may appear massive in hand specimen shows, under the microscope, alternations which are due to seasonal deposition. So also, some cases were encountered where material which was massive both megascopically and microscopically, on weathering showed the presence of seasonal bands.

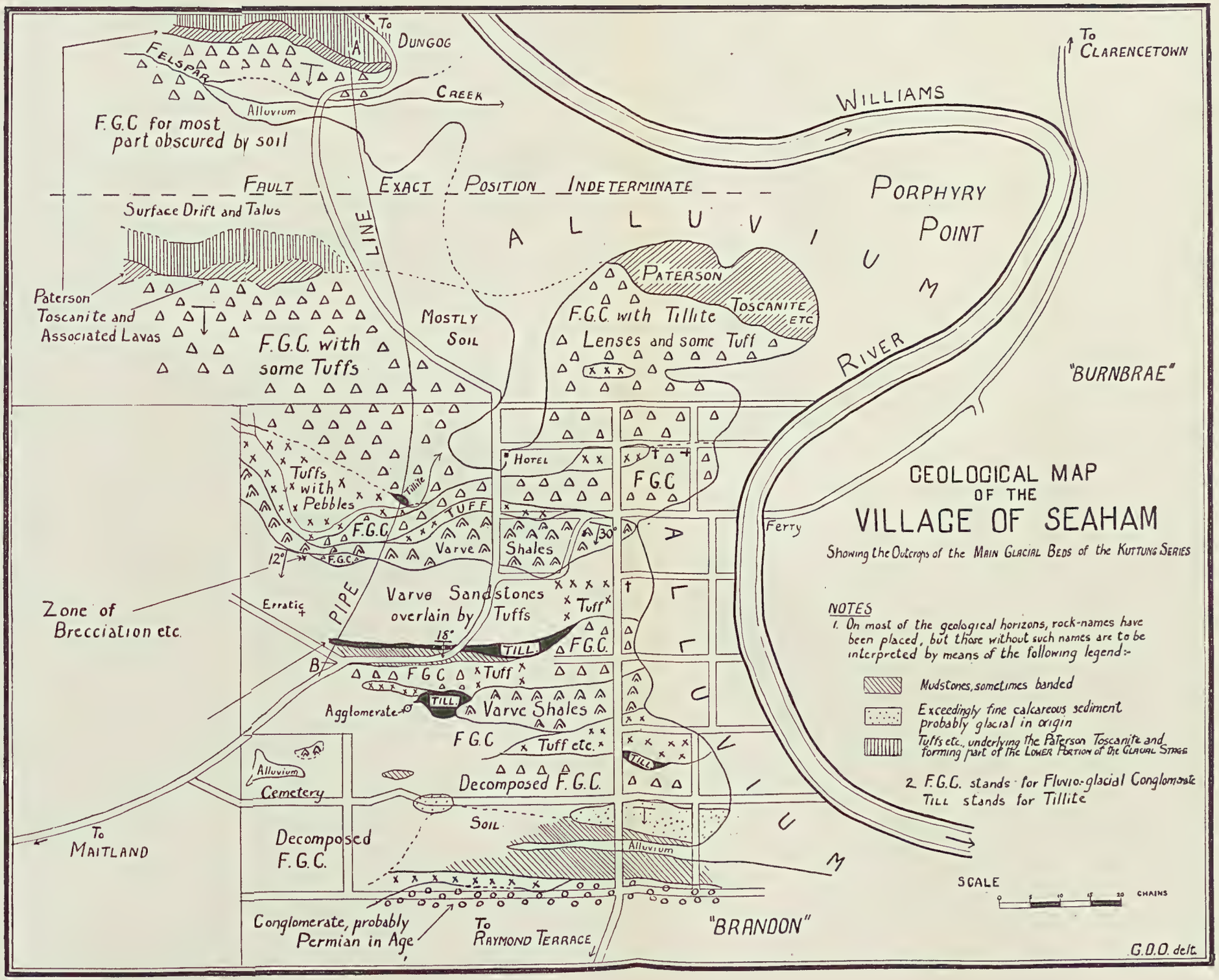
Thus there are at least four factors which may enter into the question and tend to make difficult any attempt to estimate, by counting layers in a large deposit, the time which was taken for its accumulation, and the more one considers these factors and their significance, the more one sees the need for caution in the investigation of this phase of the estimation of geological time. Thus the statement by C. A. Sussmilch that "the 200 feet of these varve shales which occur at Seaham must have taken about 3,000 years to deposit" (because the average width of a pair of seasonal layers is about two-thirds of an inch) is hardly satisfactory in view of the points raised above.

Summary indicating the Significance of some of the foregoing Results.

In the preceding paragraphs a detailed account has been given of the Main Glacial Beds of the Kuttung Series, which outcrop in the Seaham district. A map of the area shows that the beds possess quite simple tectonic features, there being one important strike fault and minor dislocations. Some of the units, in contrast to certain other beds, are discontinuous along their strike; among such units are some tillitic masses which probably represent compacted morainic material which has not been affected by fluvial action. The examination of the sequence in detail shows a total thickness of 1,890 feet of sediment.

The petrographical investigation of the beds gives much interesting information. Apart from the horizon of the Felspar Creek conglomerate, there is a distinct absence of much bouldery or fragmental material derived from the underlying Kuttung lavas. Much of the rock associated with the varve units shows evidence of having been transported by glaciers, in the presence of fresh plagioclase and orthoclase, the latter sometimes being present as spherulites.

A chemical analysis of a portion of varve rock is given, and it is of interest to find nearly 7% of alkalies present, along with high silica and low alumina.


To Dungog
Felspar
Creek
Alluvium
F.G.C for most part obscured by soil
Fault Exact Position Indeterminate
Surface Drift and Talus
Paterson Toscanite and Associated Lavas
F.G.C. with some Tuffs
Mostly Soil
Line
Alluvium
Porphyry Point
Paterson
Toscanite etc
F.G.C with Tillite Lenses and some Tuff
Williams River
To Clarencetown
"Burnbrae"
Hotel
F.G.C
Tuffs with Pebbles
Tillite
Tuff
F.G.C
Varve
Shales
12°
30°
Ferry
Zone of Brecciation etc.
Erratic
Pipe
Varve Sandstones overlain by Tuffs
Tuff
18°
Till
F.G.C.
B
F G C
Tuff
Till
Agglomerate
Varve Shales
F.G.C
Tuff etc.
Till
Alluvium
Cemetery
Decomposed F.G.C.
Soil
Alluvium
To Maitland
Decomposed F.G.C.
Conglomerate, probably Permian in Age
To Raymond Terrace
"Brandon"
Geological Map
of the
Village of Seaham
Showing the Outcrops of the Main Glacial Beds of the Kuttung Series
Notes
1. On most of the geological horizons, rock-names have been placed, but those without such names are to be interpreted by means of the following legend:-
Mudstones, sometimes banded
Exceedingly fine calcareous sediment probably glacial in origin
Tuffs etc., underlying the Paterson Toscanite and forming part of the Lower Portion of the Glacial Stage
2. F.G.C. stands for Fluvio-glacial Conglomerate
Till stands for Tillite
Scale
0 5 10 15 20 Chains
G.D.O. delt.

These figures confirm the glacial origin of the rock, by indicating the absence of much kaolinic material, and the presence of silicates which would be decomposed under ordinary conditions of weathering and transport.

Descriptions of brecciated structures and examples of contemporaneous erosion have been given and it is to these features and the associated contemporanequs contortions which the fine varve rock and varve sandstone exhibit, that some attention may be given here.

The significance of all these characteristics is that in the Seaham area there must have been much land ice in late Kuttung times. This land ice at times overrode the sediments and produced the interesting structures already described. In contrast with the sediments developed close to the ice front (like the Seaham rocks), one finds that glacial deposits formed in deep water (often under marine conditions) show an absence of the structures mentioned above. The Tapley's Hill slates or shales occurring near Adelaide, in South Australia, are regarded by Sir Douglas Mawson as being glacial in origin. They are associated with the tillites of the Adelaide Series, and possess laminations due to alternations in the material deposited, and these laminations are somewhat suggestive of varve structures. But contemporaneous contortions, current bedding and erosion features are absent, and the general facies of the rocks strongly suggests accumulation in deep water, with the resulting absence of disturbing agencies. If these Tapley's Hill rocks are aqueo-glacial in origin, their distinction from the Seaham type of deposit is very marked, and, in a general way, one may be justified in concluding, in the absence of any contradictory evidence, that glacial deposits showing contortions, contemporaneous erosion and kindred phenomena, may have been developed close to the ice-front, while evenly-banded rocks, free from contortions, etc. (like the Tapley's Hill shale), indicate deposition at a distance from the ice-front, where disturbances do not occur.

In conclusion, the writer wishes to express his appreciation of the kindness and hospitality extended to him by Mr. L. B. Fisher and family of "Brandon" during his visits to the area in 1922-24; and in connection with the preparation of the paper he is indebted to Professor David and Assistant-Professor Browne for helpful discussion.

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EXPLANATION OF PLATE XIII.

Geological Map of the village of Seaham, showing the outcrops of the Main Glacial Beds of the Kuttung Series.

NOTES ON AUSTRALIAN DIPTERA, No. vi.

By J. R. Malloch.

(Communicated by Dr. E. W. Ferguson.)

(Twelve Text-figures.)

[Read 27th May, 1925.]

In this paper I present some notes on and descriptions of Australian acalyptrate Diptera. As in the case of material dealt with in preceding papers on these insects, the types will be returned to Dr. Eustace W. Ferguson to deposit in some Australian museum where they may be available to subsequent workers.

Family Sciomyzidae.

This family is very closely allied to the Sapromyzidae and much more difficult to distinguish from it than one would expect if he judged relationships by existing catalogues and books on classification. The European fauna contains, for the most part, species which are readily assigned to one or other of these families by the use of characters listed for that purpose by Schiner and the earlier authors. But when one has before him species from all over the world, it is a much more difficult matter to separate the families. General habitus is a good index in Europe, but this fails in the Orient and Australasia. In fact the comparative size of the basal and anal cells of the wings, small in Sapromyzidae and large in Sciomyzidae, is of no value in many cases, and new characters must be discovered if we are to maintain both families. That the families ought to be kept separate is my personal opinion, based upon a knowledge of the habits and habitats of the adults. So far as I have seen, the larvae of the Sciomyzidae are found in water, and in some cases in molluscs as parasites, and the adults in marshy situations almost exclusively. On the other hand I have found no aquatic nor semiaquatic larvae of Sapromyzidae, and the adults are not found in marshy spots, but in woodlands.

It is possible that my attitude in the matter of separating these families is influenced by these biological factors, but in any case I have decided that until more data are available the families ought to remain separate. With this end in view, I have examined carefully the structural details of the species before me and find that they differ in the extent of the sixth wing vein more noticeably than in any other obvious character. This vein in Sciomyzidae is traceable to the margin, while in Sapromyzidae it is not. Ordinarily the prosternal plate in the former is small, while in the latter it almost fills the space between the fore coxae. The mesopleura in Sapromyzidae usually has a strong bristle on its hind margin which is rarely present in Sciomyzidae. Both families lack vibrissae, have the auxiliary vein of wing complete and distinctly separated from first on its entire length, the discal and basal cells separated by a cross-vein, the

anal cell and sixth wing-vein present, and the tibiae with distinct preapical dorsal bristle.

I have seen but two genera from Australia, *Helosciomyza* Hendel and *Melina* R.-D.

Genus Helosciomyza Hendel.

This is an aberrant genus possessing long bristles on the costa, a character common to genera of Helomyzidae, but rare outside that family. In other respects it is a typical sciomyzid. Hendel described the genus in 1917 (*Deut. Ent. Zeit.*, p. 33). I have described two species from New Zealand and placed *rara* Hutton in the genus (*N.Z. Journ. Sci. and Tech.* 5, 1922, 228).

Helosciomyza ferruginea Hendel.

♂.—Brownish-yellow. Frons orange coloured, orbits and triangle whitish; face testaceous yellow. Thorax with four rufous-brown vittae, the broad lateral pair narrowly divided by a grey line behind the suture; scutellum grey on sides. Fore and hind femora and tibiae dark at apices, the fore femora indistinctly so; hind tibia with a brown band at base; apical segment of tarsi dark. Both cross-veins narrowly clouded.

Each orbit with two bristles; arista pubescent. Sternopleura with two or three bristles; mesopleura bare; mesonotum with two pairs of dorsocentral bristles and a pair of long prescutellar acrostichals. Hind tibia with two preapical dorsal bristles.

Length, 5.5 mm.

Originally described from Victoria. I have one specimen from Como, N.S.W. (H. Petersen).

Family Sapromyzidae.

I have received, from various sources, material belonging to this family and present data upon three previously described and one new species.

Genus Steganopsis de Meijere.

This genus was founded for the reception of a Javanese species, *pupicola* de Meijere, which feeds in the larval stages in the chrysalides of a butterfly. Later Hendel described a species from Formosa, and Kertesz one, *vittithorax*, from New South Wales, while Frey erected a new genus, *Steganolauxania*, for the reception of the North American species *Lauxania latipennis* Coquillett, which was included in *Steganopsis* by some authors. This genus, I think, is unnecessary, *latipennis* agreeing very closely with the species I have seen from Australia and the Orient.

I also consider it as very probable that the species described by Hendel is a synonym of the species redescribed below; Kertesz's species certainly is.

Steganopsis melanogaster (Thomson).

Head yellow; frons opaque, ocellar spot black; face glossy, with a black spot on each side, and a brown mark below eye; antennae yellow, third segment largely brownish-fuscous; apices of palpi black. Thorax tawny-yellow, dorsum with about 6 brownish-red vittae, the sides of which are usually dark, sometimes black. Abdomen pitchy coloured, paler in male, glossy. Legs tawny-yellow, fore tarsi more or less blackened. Wings brownish-yellow, darkest along costa, becoming hyaline behind, apices narrowly hyaline.

Anterior orbitals incurved, posterior pair curved backward; first and second antennal segments longer than wide, both haired below, third almost twice as long as first and second combined and nearly six times as long as thick; arista short haired; face convex; eye higher than long; labrum high and distinct. Thorax with three pairs of dorsocentral bristles; prescutellar acrostichals distinct; intra-alar absent; sternopleural 1; scutellum flattened, elongate, rounded apically. Fore femur without a comb. Wing venation as in Figure 1.

Length, 3-4 mm.

Locality, Botany Bay, N.S.W. (H. Petersen). Originally described from Sydney.

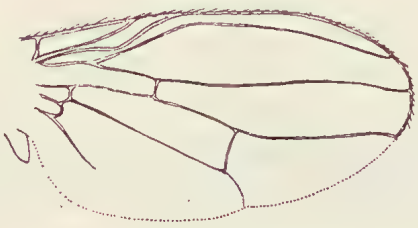

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Fig. 1. *Steganopsis melanogaster*, wing.

I have before me a male specimen from the Philippine Islands which is, except for being paler in colour, almost identical with the male of *melanogaster*, and which is apparently *convergens* Hendel. As Thomson's species is the oldest in the genus I do not attempt to treat at this time with the synonymy. It is strange that in Thomson's description nothing is mentioned of the head characters of his type; the head may be missing in this.

Genus TRIGONOMETOPSIS novum.

Generic characters.—Similar to *Trigonometopus* Macquart, the face retreating below, eyes elongate oval, each orbit with two bristles, antennae short, arista subnude, thorax with three pairs of dorsocentrals, outer cross-vein beyond middle of wing, third vein not curved, costa to apex of fourth vein, and hind tibia with a preapical bristle. The general habitus of the two genera is similar and the black spot between antennae and eyes is present in both, though in the new genus it is not noticeably hairy. The presence of a well developed presutural bristle in the new genus distinguishes it from *Trigonometopus*.

Genotype, *Oxyrhina binotata* Thomson.

TRIGONOMETOPSIS BINOTATUS (Thomson).

A yellowish testaceous species, with the abdomen more shining than thorax. A longitudinal line of brown colour extends from vertex to anterior margin of frons; a black spot between each antenna and eye; and a pair of small round black spots on middle of face. Dorsum of thorax brownish-yellow, paler on lateral margins, darker on lines of dorsocentral bristles and bordering the pale lateral margins, and with a blackish central vitta which is obscured by greyish dusting; pleura with a faint brownish vitta; scutellum pale in centre. Legs yellow. Wings clear, yellowish on anterior portion, veins brown. Halteres yellow.

Frons about 1.5 as long as wide; cheek about one-third of eye height; proboscis thick. Acrostichals in two series, prescutellar pair of moderate size; scutellar

bristles subequal. Inner cross-vein almost at middle of discal cell; last section of fourth vein only about one-fifth longer than preceding section; outer cross-vein at a little more than half its own length from apex of fifth vein.

Length, 3.5 mm.

Originally described from Sydney, from whence I have a female specimen.

The species described from the island of Guam as *Trigonometopus setosus* by Knab does not belong to that genus. It agrees fairly well with *Trigonometopsis*, but has the first pair of dorsocentral bristles on thorax in front of suture instead of just at it, and the cheeks with some long hairs along margins which are quite conspicuous. The frons is less protruded beyond eyes and the face is unspotted. This species should apparently be located in *Panurgopsis* Kertesz and not in *Trigonometopsis*, with the genotype of which it has much in common.

Genus Sapromyzosoma Malloch.

This genus is distinguished from its allies by the lack of an intra-alar thoracic bristle, and the continuation of the short stubby black costal setulae to the apex of third vein.

It is possible that this genus is the same as *Homoneura* van der Wulp, but I have not seen an authentic specimen of *picea* v. d. Wulp, the genotype, so cannot give a definite opinion.

There are a number of Australian species of the genus, which appears to occur over most, if not all, of the faunal regions of the world. The species listed below appears to belong here, but the wing-tips are imperfect in the only specimen available to me so that I cannot be absolutely certain of this.

Sapromyzosoma maculifrons (Macquart).

Testaceous yellow, shining. Ocellar spot, a spot on each side of interfrontalia at middle of frons, basal two antennal segments, apices of palpi, and apices of tibiae black; abdomen pitchy; apices of mid and hind femora narrowly dark. Wings clear. Halteres yellow.

Arista bare. Thorax with three pairs of dorsocentral bristles, the anterior pair short; prescutellar acrostichals strong; disc of thorax with short black hairs; scutellum subconvex. Abdomen broad, hypopygium not conspicuous. Fore femur without an anteroventral apical comb, the posteroventral bristles on apical half only; hind femur without a preapical anteroventral bristle; all tibiae with distinct preapical bristle. Inner cross-vein at middle of discal cell and almost below apex of first vein; outer cross-vein at a little more than half its own length from apex of fifth vein.

Length, 3 mm.

Originally described from Tasmania. One male, Seaford, Victoria (W. F. Hill).

Genus Sapromyza Fallen.

In this genus the intra-alar bristle of thorax is lacking, and the short black setulae of the costa are discontinued about midway between apex of second and third veins, gradually becoming evanescent. I give the description of one species.

Sapromyza atriventris, n. sp.

♂ ♀.—Deep black, shining, thorax, fore coxae, and all trochanters orange yellow, mid and hind tibiae and tarsi more or less distinctly yellowish at bases. Wings yellowish, halteres brownish.

Frons entirely shining, orbits but little differentiated, both pairs of bristles long, sloping backwards; ocellars small; postverticals quite large; antennae inserted much above middle of profile, large, basal segment quite distinct, about as long as second, bare below, third about 1.75 as long as first and second combined and about twice as long as broad, rounded at apex; arista slender and long, distinctly pubescent; face slightly receding in profile, convex, sides a little paler than centre and with dense silvery pruinescence on entire length of parafacials, which extends along cheeks for a short distance; cheek not as high as width of third antennal segment; eye narrowed below, higher than long. Thorax with three pairs of dorsocentral bristles and a pair of long setulae in front of anterior pair, the prescutellar acrostichal pair long; scutellum convex, the four bristles subequal in length; mesopleura with one strong bristle; anterior sternopleural bristle short. Abdomen ovate, male hypopygium of moderate size. Fore femur without anteroventral comb; mid femur with anterior bristles distinct; hind femur without preapical anteroventral bristle; preapical tibial bristle distinct on all legs. Inner cross-vein a little before middle of discal cell; outer cross-vein at about half its own length from apex of fifth vein.

Length, 5-5.5 mm.

Type, female, and two paratype females, Illawarra, N.S.W.; allotype, Como, N.S.W. (H. Petersen).

No species known to me from any part of the world has the same colours of body and legs as this one. Possibly the nearest related species may prove to be *nigriceps* Macquart, also an Australian species, but it has the antennae yellow at bases and the legs and abdomen partly yellow, and in other respects does not fit the species above described.

Genus Poecilohetaerus Hendel.

This genus was erected for the reception of a single species, *decora* Schiner, which name, being preoccupied, was replaced by *schineri* Hendel. The genus is distinguished from *Sapromyza*, to which it is closely allied, by the anterior pair of orbital bristles being incurved instead of backwardly curved. In other respects the genera are very similar.

Poecilohetaerus schineri Hendel.

A deep black species with two moderately broad and very conspicuous white pruinescent vittae extending from anterior margin of frons over disc of thorax to apex of scutellum, a less distinct vitta on sides of mesonotum and three similar on pleura; parafacials and postocular orbits white, centre of cheek black; mesonotum with a pale brown median line. Legs black, mid and hind tarsi and bases and middle of mid and hind tibiae yellowish. Wings yellowish. Halteres blackish.

Arista pubescent; third antennal segment about twice as long as broad. Thorax with four pairs of strong dorsocentrals, the anterior pair in front of suture; one moderately strong pair of prescutellar acrostichals and in front of these a few weak paired hairs; sternopleura with two bristles; scutellum with disc slightly flattened, the apex a little transverse, bristles four in number. Fore femur without anteroventral comb; all tibiae with preapical bristle distinct. Costal black setulae discontinued before attaining apex of third vein.

Length, 3-4 mm.

Known only from Eastern Australia. I have a number of specimens from Botany Bay and Illawarra, N.S.W. (Petersen).

Family Ortalidae.

I take this opportunity to record the occurrence of the following European species amongst some material sent to me by Dr. C. F. Baker from Australia.

Chrysomyza aenea Fabricius.

I believe that *melanopsis* Walker may be a synonym of this species. The species occurs also in North America, having been introduced in commerce no doubt.

Family Borboridae.

I have seen very few species of this family from Australia and pending the receipt of more material record but two species, one of them new.

Genus Sphaerocera Latreille.

This genus is distinguished from its allies by the lack of bristles on the scutellum; the position of the cross-vein at base of discal cell, which is basad of the one closing anal cell, causing the second basal cell to be shorter than the anal. There are other distinctions, but the above should suffice for the recognition of the genus. *Leptocera* has the fifth vein incomplete, the anal cell and cross-vein dividing second basal and discal cells absent. This genus occurs also in Australia, but I have not yet worked up the species I have on hand.

Sphaerocera curvipes Latreille.

This species has generally been referred to as *subsultans* Fabricius, due to an early error in identification. It is the largest known species of the genus, averaging about 4 mm. in length, and is very widely distributed.

I have seen one specimen from Botany Bay, N.S.W. (H. Petersen).

The larvae and adults live on manure and carrion.

Genus Borboroides novum.

Generic characters.—Each orbit with two outwardly curved bristles, inner vertical bristle incurved, outer outwardly curved; ocellars long; postverticals convergent; face concave; genal bristle absent; vibrissae present; proboscis stout. Thorax with 1 humeral, 1 presutural, 2 notopleurals, and 2 pairs of dorsocentrals; scutellum with 4 bristles; sternopleura with one or two bristles. Mid tibia with 2 long dorsal bristles near apex; hind metatarsus longer than second segment. Wing venation as in Figure 2.

Genotype, the following species.

Borboroides atra, n. sp.

♀.—Black, shining, lower part of parafacials, fore coxae, and bases of fore femora obscurely yellowish. Wings hyaline. Halteres black.

Frons smooth and shining, with some short hairs; third antennal segment higher than long, rounded in front; arista pubescent. Dorsum of thorax regularly but not densely haired, that of scutellum bare. Apical genital organs a pair of slender lamellae. Mid femur with a series of short bristles on apical half of anterior surface.

Length, 2 mm.

Type, Sydney, N.S.W., 1.11.24.

This genus has as its closest relative *Borborus* Meigen, but differs materially from it in venation of wing, in the presence of two dorsal bristles on the mid tibia such as are found in some species of *Leptocera*, and in the elongate basal segment of hind tarsus. From *Leptocera* it may be readily distinguished by the presence of the basal and anal cells of the wing.

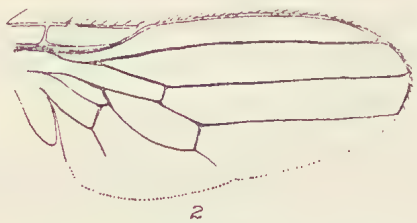

Fig. 2. *Borboroides atra*, wing.

The genus *Leptocera* occurs in Australia, the species having been referred to under the generic name *Limosina*.

Family Ephydridae.

Subfamily Ephydrinae.

Genus Hecamede Meigen.

This genus has the frontal triangle with two or three pairs of short proclinate bristles in front of the anterior ocellus, each orbit with usually two short bristles, second antennal segment with a short forwardly directed apical bristle, and some finer hairs basally, arista short, with about six long hairs above, face concave on upper half, with a nose-like process in centre, the tip of which is invariably glossy black, three or four bristles on each side of lower half of face which are situated on slightly elevated black bases, cheek nearly as high as eye, genal bristle weak, clypeus slightly projecting. Thoracic bristles short, only the prescutellar dorsocentral bristles distinct. Costa to apex of fourth vein. Mid tibia without long dorsal bristles.

Hecamede albicans Meigen.

Black, densely pale grey pruinescent, almost whitish on abdomen, more yellowish on dorsum of thorax. Anterior margin of frons slightly rufous; antennae rufous. Bases of tibiae, and the tarsi yellowish, apices of latter darker. Wings white, veins yellowish. Halteres white.

Length, 2.5 mm.

One female, Encounter Bay, S.A., on beach.

Hendel has described a species under the name *persimilis* from Formosa and de Meijere has described two others from Java. I consider it very probable that *persimilis* is merely a form of *albicans*.

I have compared the Australian specimen with European examples and can find absolutely no distinguishing characters either of colour or structure.

Subfamily Canaceinae.

In a previous contribution on the Diptera of Australia, I presented a key for the recognition of the genera of this subfamily under the impression that subse-

quent collecting would disclose the presence of other genera than the one I then had from this continent. I now present the description of a new species of *Canace* recently received from Dr. Ferguson. The dark facial stripe appears distinctive, though the structure of the head is also characteristic.

CANACE ALBICEPS, n. sp.

♀.—Frons opaque, olive brown, the orbits greyish anteriorly; face densely white pruinescent, with a narrow dark vertical stripe, cheeks silvery white; clypeus whitish grey; palpi tawny-yellow; antennae black. Dorsum of thorax olive-brown, with very faint brown vittae, the most obvious one in centre; pleura grey. Abdomen dark greyish on dorsum, paler below. Legs greyish fuscous, extreme apices of femora, bases and apices of tibiae, and most of tarsi yellowish. Wings slightly greyish, veins fuscous. Halteres pale yellow.

Eye about 1.75 times as long as high, narrowest part of cheek (at anterior margin of eye) about as high as eye; a long upcurved bristle on cheek below middle of eye and three along its lower margin on anterior half, the hindmost one upcurved; each orbit with four long bristles directed over eye; about four pairs of incurved interfrontal bristles present; ocellar bristles long, divergent, in line with anterior ocellus; postverticals divergent, small; centre of lower margin of face slightly angularly produced, not transverse. Thorax with four pairs of dorsocentral bristles, the acrostichals sparse, paired; scutellum with two long apical, and two shorter basal bristles, and two discal setulae; pleura too much damaged to determine characters in type, but the sternopleura has no strong bristles. First visible abdominal tergite elongate; genital thorns two in number. Fore femur without anteroventral comb of bristles; fore tarsus dilated apically, basal segment longer than next three combined, each of latter broader than long, neither of them as long as fifth, the claws long and curved. Last section of fifth vein subequal in length to penultimate section of fourth; veins 3 and 4 parallel apically; penultimate and ultimate sections of costa subequal.

Length, 2 mm.

Type, Sydney, 10.9.21.

Family Drosophilidae.

DROSOPHILA POECILITHORAX, n. sp.

♀.—Head fuscous, frontal orbits, triangle, face and cheeks densely grey pruinescent, palest on frons, anterior half of frons pale orange yellow, posterior half of interfrontalia brownish-red; second antennal segment brownish, third black, mouth-parts fuscous; a faintly indicated dark spot surrounding bases of orbital bristles. Thorax black, densely bluish-grey pruinescent on dorsum and with rather large dark brown dots at bases of hairs and bristles; humeri and scutellum concolorous with disc, the scutellum with a curved dark brown streak on each side of median line extending the entire length. Abdomen shining fuscous, without distinct markings in type. Legs fuscous yellow, darkest on middle of femora. Wings clear.

Facial keel rounded, becoming broad and disappearing before reaching mouth; labrum quite prominent; cheek fully one-third of the eye height, slightly produced at vibrissal angle, with a series of marginal bristles; arista with three hairs above and one below; anterior two orbital bristles at almost same point; postvertical bristles long. Only two series of acrostichal setulae between dorsocentrals, the prescutellar pair quite pronounced; basal pair of scutellar bristles much smaller

than apical pair. Legs normal. Second costal division twice as long as first and but little longer than third, the latter fully three times as long as fourth; penultimate section of fourth vein not more than one-third as long as ultimate and nearly as long as ultimate section of fifth; outer cross-vein not more than one-third as long as apical section of fifth vein.

Length, 1.25 mm.

Type, Sydney, 26.2.24.

This species belongs to the same section as *obsoleta* Malloch, *repleta* Wollaston, and *hydei* Sturtevant. It differs from the first-named species in having a distinct facial keel, only two series of intradorsocentral setulae, and entirely different wing venation. From the other two species it differs in its smaller size, less robust form, unspotted abdomen, venation of wing, and several other respects.

Dr. Ferguson has suggested to me that *australis* Duda is probably the same as *obsoleta* Malloch. The descriptions agree very well, the venation given by Duda being in accord with that of my species and the thoracic characters similar. There are, however, a few points of difference and without an examination of the type of *australis* it were better to leave the matter in abeyance, though there is a very great probability that the species are the same.

Family Agromyzidae.

Subfamily Milichiinae.

Genus Stomosis Melander.

Related to *Desmometopa*, differing in having the frons without an M-shaped black mark; hind tibiae not dilated; mesopleura bare. I figure the head showing the long geniculated proboscis and other features (Fig. 3).

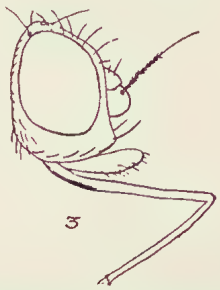

Fig. 3. *Stomosis flavoscutellata*, head from side.

The genus *Stomosis* was erected for the reception of *luteola* Coquillett which had been previously placed in *Desmometopa*. I have compared the following species with the type of Coquillett's species and find that they agree in generic characters though specifically distinct. *Luteola* is American.

Stomosis flavoscutellata, n. sp.

♀.—Head orange-yellow, upper half of orbits, frontal triangle, and occiput black; third antennal segment brown above; arista fuscous; proboscis brown. Thorax glossy black, broadly yellow along lateral margins of mesonotum from humeri to base of scutellum; pleura black; scutellum yellow. Abdomen glossy black. Legs yellow, all femora black except at bases and apices. Wings clear. Halteres yellow.

Ocellar triangle narrow, extending well over midway to anterior margin of frons; postvertical and ocellar bristles long, the former cruciate; upper three orbital bristles curved outward over eye, lower three or four incurved; interfrontal hairs very weak; profile as in Figure 3. Thorax with two pairs of dorsocentrals; prescutellar pair of acrostichals distinct; four series of setulae between dorsocentrals; basal pair of scutellar bristles much shorter than apical pair which are divergent. Hind femur with a preapical anteroventral bristle. Last section of fifth vein as long as penultimate section of fourth, the latter about one-fourth as long as ultimate section of fourth.

Length, 2 mm.

Type, Melbourne, Victoria, 14 November, 1923.

STOMOSIS VITTATA, n. sp.

♀.—Differs from the preceding species in having the upper orbits yellow; dorsum of thorax with three broad black vittae on a yellow ground, the median one extending over base of scutellum; the pleura instead of being almost entirely black have a black vitta along upper margin, the sternopleura black and two other marks, one on pteropleura and the other on hypopleura. The abdomen is not entirely black above, but has the base yellow, the pale colour extending almost to hind margin of first visible tergite in middle, and the bases of the other tergites yellow. Apices of tibiae rather broadly blackened; tarsi darkened apically.

Structurally similar to preceding species.

Length, 2.25 mm.

Type and paratype, Sydney, 3.10.24, and 26.10.24.

Subfamily AGROMYZINAE.

Genus CERODONTA Rondani.

The members of this genus are distinguished from those of *Agromyza* by the very pronounced spike-like apex of third antennal segment, and the presence of but one pair of scutellar bristles. The postscutellum is generally quite distinctly developed, sometimes extending well beyond apex of scutellum.

I have seen two species from Australia, both of them apparently new.

CERODONTA AUSTRALIS, n. sp.

♀.—Head yellow, interfrontalia generally darker than orbits, ocellar triangle, occiput, third antennal segment, and arista black. Thorax black, densely grey

Fig. 4. *Cerodonta australis*, antenna.
Fig. 5. *Cerodonta robusta*, antenna.

pruinescent, with indications of two darker vittae along the lines of dorsocentrals. Abdomen black, apices of tergites with a yellow line. Legs yellow, apices of tarsi infuscated. Wings greyish, radius yellow basally. Halteres yellow.

Third antennal segment as in Figure 4. Thorax with four pairs of dorsocentrals, and one pair of acrostichal setulae behind suture and in line with the second pair of dorsocentrals. Venation normal.

Length, 2.5 mm.

Type and three paratypes, Sydney, 28 October, and 21 September, 1923, and 14 September, 1924.

This species is very similar to *denticornis* Meigen, but I have examined many specimens of the latter and have found none in which the acrostichal setulae are present as in *australis*.

In Europe and North America *denticornis*, in the larval stages, does considerable damage to wheat and hay by mining in the stems.

Cerodonta robusta, n. sp.

♀.—Head lemon-yellow, ocellar spot and upper occiput black, antennal foveae, labrum, and apex of third antennal segment darkened; arista fuscous. Thorax shining black, broadly yellow on lateral margins to lateral angles of scutellum; upper half of pleura yellow; scutellum black. Abdomen black, the hind margins of tergites yellow. Legs dirty yellow, tibiae and tarsi subfuscous. Wings greyish, veins conspicuous. Halteres yellow.

A robust species, much stouter than the others in the genus, and more resembling some species of *Agromyza*. Antennae shorter than usual in the genus (Fig. 5); head large; arista pubescent. Thorax stout, with the usual four pairs of dorsocentrals; about six series of setulose hairs between the dorsocentrals; scutellum convex; postscutellum low and small. Abdomen stout. Legs stouter than in *australis*. Wings broader than in that species; cross-veins separated by about length of outer cross-vein; last section of fifth vein subequal to preceding section; last section of fourth vein about seven times as long as preceding section.

Length, 3 mm.

Type, Sydney, N.S.W., 20.11.24. Paratype, same locality, 14.9.24.

Distinguished from any species of the genus by the short antennae, and the number of series of setulose hairs between the dorsocentral bristles on thorax.

Agromyza pusilla Meigen.

This cosmopolitan species is represented by a number of specimens taken at Sydney, N.S.W. One of these is mounted along with a specimen of *Cocnosia acuticornis* Stein of which it was evidently the prey.

The species, in the larval stages, mines in the leaves of a large number of plants both cultivated and wild. Amongst those recorded are *Nasturtium*, cotton, peas, cabbage, various clovers, *Solanum*, *Valeriana*, *Eupatorium*, *Euphorbia*, etc.

Genus Fergusonina Malloch.

In a lot of Diptera recently received from Dr. Ferguson I find four specimens of this genus, three of them males, which sex I did not have before me when I described the genus. I note that the venation of some of the specimens shows a departure from that of the genotype in having the outer cross-vein distinct. There are, however, no important changes necessary in the generic definition previously given, the remarkable flattened head, with the much enlarged frontal lunule, being characteristic of all.

I give below a key for the identification of the species now on hand.

Key to Species.

1. Head and thorax yellow in both sexes, only a blackish tinge round ocelli; venation of wing as in Figure 6 ..... *microcera* Malloch.

   Head with at least the ocellar spot, and thorax with at least partial vittae, black .. 2

2. Third antennal segment deep black; venation of wing as in Figure 7 .. *atricornis*, n. sp.
   Antennae entirely clear yellow 3

3. Disc of thorax with six black vittae, median pair extending from anterior margin to beyond suture, lateral pairs not extending to anterior margin, but reaching beyond hind margins of median pair; scutellum entirely yellow; venation of wing as in Figure 8 ..... *flavicornis*, n. sp.

   Disc of thorax black, lateral margins yellow; scutellum black at base; venation of wing as in Figure 9 ..... *scutellata*, n. sp

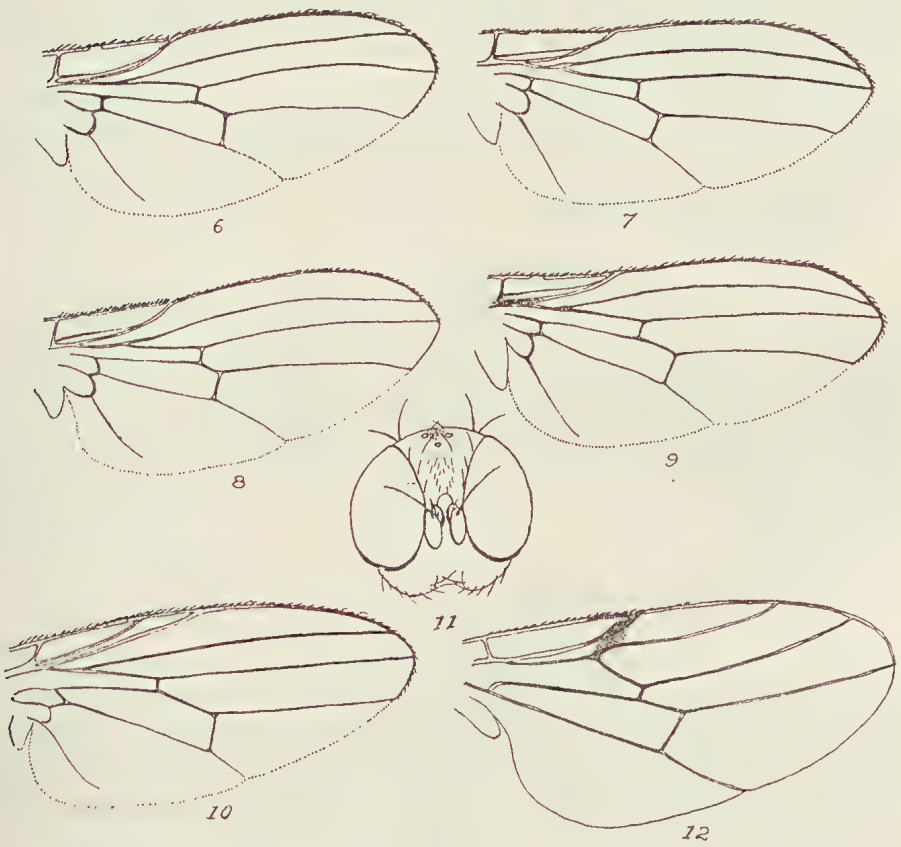

Fig. 6. *Fergusonina microcera*, wing.
Fig. 7. *Fergusonina atricornis*, wing.
Fig. 8. *Fergusonina flavicornis*, wing.
Fig. 9. *Fergusonina scutellata*, wing.
Fig. 10. *Pseudoleucopis magnicornis*, wing.
Fig. 11. *Aphantosoma nigridorsum*, head from front.
Fig. 12. *Euhippelates pallidiseta*, wing.

FERGUSONINA MICROCERA Malloch.

The male of this species is all yellow, except dark rings round the ocelli. The abdominal and femoral bristles are mostly luteous.

Fifth visible abdominal tergite about as long as the two preceding tergites combined; hypopygium with base subglobose, the forceps long, slender, heavily chitinized, directed forward below venter. Hind femur stout, with a long preapical bristle and one or two shorter bristles basad of it on anteroventral surface.

Length, 1.5-1.75 mm.

Male, Sydney, N.S.W., 29.10.24.

FERGUSONINA ATRICORNIS, n. sp.

♂.—Ocellar spot and third antennal segment black. Thorax with six faint rufous vittae, the anterior margins of the fused median pair and the posterior extremities of the lateral pairs black; postnotum black. Abdominal tergites blackish at bases, especially laterally. Otherwise the species is similar to the preceding. Wings smoky hyaline.

Orbital setulae not so large as in *microcera;* only one vertical bristle on each side of frons, very long; ocellars short. Anterior pair of prescutellar dorsocentral bristles very short. In other respects as *microcera* except in venation.

Length, 2 mm.

Type, Sydney, N.S.W., 29.10.24.

FERGUSONINA FLAVICORNIS, n. sp.

♀.—Lemon-yellow, shining. Head with a black spot over ocelli. Dorsum of thorax with six black vittae, the lateral pairs fused in front of suture and extending farther backwards than median pair, all of them brownish just in front of suture; pleura with a few dark patches; postnotum black. Abdomen with the tergites all broadly black, only the narrow hind margins and their sides yellow; ovipositor glossy black. Legs yellow. Wings greyish hyaline. Halteres yellow. All hairs and bristles black.

Head as in *microcera.* Anterior of the two pairs of dorsocentral bristles of moderate length.

Length, 1.75 mm.

Type, Sydney, N.S.W., 30.11.24.

FERGUSONINA SCUTELLATA, n. sp.

♂.—A much darker species and more strongly bristled than the preceding one. Arista black, sides of occiput as well as ocellar spot black. Only the lateral margins of mesonotum, sutures of pleura, and apical margins of scutellum yellow. Dorsum of abdomen except narrow margins of tergites 1 to 4 and apical half of 5 black. Legs yellow, a fuscous streak on anterior side of hind femur. Wings greyish hyaline, veins conspicuous. All bristles black.

Orbital bristles quite distinct. Similar to other species in chaetotaxy, etc.

Length, 2 mm.

Type, Sydney, N.S.W., 1.1.25.

Subfamily OCHTHIPHILINAE.

This subfamily lacks the bristles on vibrissal angles of cheeks, has the auxiliary vein of wing complete and separate from first on its entire length, and the postvertical bristles parallel or convergent.

Genus Pseudoleucopis novum.

Generic characters.—Wing as in Figure 10, the auxiliary vein quite distinct and more widely separated from first than usual in this subfamily. Frons with two pairs of orbital bristles; ocellars distinct; postverticals rather small, convergent; antennae large; arista subnude; vibrissae lacking. Thorax with two pairs of dorsocentrals, the prescutellar acrostichals distinct; scutellum with four bristles; mesopleura bare; sternopleura with one long and one short bristle. Legs normal.

Genotype, the first described species herein.

Pseudoleucopis magnicornis, n. sp.

♀.—Head black, frons opaque, orbits, lunule and cheeks whitish pruinescent; face glossy in centre. Thorax slightly shining, black, with dense lead-grey pruinescence. Abdomen glossy black, with faint brownish dusting. Femora fuscous, fore coxae, tibiae, and tarsi brownish-yellow. Wings clear. Halteres white.

Frons fully one-third of head width, a little longer than wide; orbits distinct to below upper bristle, the anterior bristle on an isolated differentiated spot; third antennal segment about three times as long as height of cheek and about one-fourth longer than high; face glossy, with a sharp vertical keel or carina in centre which slopes off to sides. Thorax with more than eight series of intradorsocentral setulae. Legs rather stout. Wing as in Figure 10.

Length, 2.25 mm.

Type, North Harbour, Sydney, N.S.W., 30.3.23.

Pseudoleucopis flavitarsis, n. sp.

♀.—Differs from the preceding species in having the orbits grey and differentiated on their entire length, the face does not have a sharp central keel or carina, but is slightly convex in centre and entirely grey pruinescent, third antennal segment smaller, and the legs black, with only the tarsi yellow. Otherwise as *magnicornis*.

Length, 2.5 mm.

Type, Sydney, N.S.W., 12.10.24.

Family Geomyzidae.

This so-called family is difficult to define and may yet have to be linked with Agromyzidae, but tentatively I allow it to stand, in the hope that when I get round to placing before students of the order my key to the families of acalyptrates, I may be able definitely to assign to the different groups the status which they appear to be entitled to. Later I will revert to this subject; meanwhile, I merely describe a new species of one genus which has been located in the family by authors.

Genus Aphaniosoma Becker.

This genus was erected for the reception of an Egyptian species described by Becker. Later I described a North American species which I placed in the genus. I have not seen the genotype but, except for the narrower cheeks of the present species and the presence of a mesopleural bristle, which is not mentioned by Becker, the species appears to belong here. I figure the head of the new species (Fig. 11).

Aphaniosoma nigridorsum, n. sp.

♂.—Frons yellow, face and cheeks yellowish-white, occiput black, its lower margin yellowish, ocellar triangle black, antennae reddish-yellow, darkened at the insertion of arista, palpi yellow, arista fuscous. Thorax stramineous, disc broadly black, shining, with slight grey pruinescence, the hind margin of the black mark with an angulate notch in centre leaving a yellow triangle in front of scutellum, sternopleura black, except above, mesopleura black on lower margin; postnotum black; scutellum yellow, black on sides at base. Abdomen shining black, yellow at extreme base. Legs yellow. Wings hyaline. Halteres yellow.

Head as in Figure 11. Thorax with two pairs of dorsocentral bristles, the anterior pair short; prescutellar acrostichals distinct; scutellum slightly flattened; basal pair of bristles much shorter than apical pair, which are convergent. Veins 3 and 4 slightly and gradually convergent apically; inner cross-vein at two-fifths from apex of discal cell; last section of fifth vein distinctly longer than penultimate section of fourth, the latter not more than one-fourth as long as ultimate section of fourth.

Length, 1.5 mm.

Type, Sydney, N.S.W., 16.12.23. Paratypes, same locality, October and November, 1923-24, 12 specimens.

This species is much darker in colour than either of the already described forms and the thoracic markings are distinctive.

Family Chloropidae.

Subfamily Chloropinae.

Genus Chloropella novum.

Generic characters.—Ocellar bristles distinct, divergent and directed forward and upward; orbits each with three or four short but distinct bristles; vertex with two bristles on each side, the inner one situated in front of the outer, incurved, the outer outcurved, both rather distant from eye; triangle present; interfrontalia haired; arista normal, dorsal on the rounded third antennal segment; eyes very short haired; face subvertical, not carinate; cheek normal; proboscis stout. Thorax with a short humeral, one short anterior and a long posterior notopleural, one pair of long prescutellar dorsocentral bristles and a pair of long presuturals; scutellum with the basal pair of bristles much shorter than apical pair. Legs long and rather slender, hind tibia without a sensory area. Costa to a little beyond apex of third vein, the latter ending in front of the fourth behind, apex of wing, the veins divergent.

Genotype, the following species.

Chloropella bipartita, n. sp.

♀.—Shining pale yellow. A black spot over ocelli and another on middle of occiput. Thoracic dorsum with three rufous vittae, the median one extending from anterior margin to beyond suture and black on both extremities, the lateral pair not extending so far forward but carried farther backward, and only their posterior extremities black; pleura without black marks, sternopleura orange coloured below; scutellum with a fuscous mark on each side at base; postnotum black. Abdomen with a small round fuscous spot on each side of first tergite. Legs yellow. Wings clear.

Frontal triangle extending to anterior margin of frons; arista pubescent; cheek about one-sixth of the eye height. Dorsum of thorax with numerous pale

decumbent hairs; disc of scutellum slightly flattened, with a few short dark hairs. Abdomen tapered apically. First costal division a little shorter than third, the latter fully two-thirds as long as second; penultimate section of fourth vein fully twice as long as outer cross-vein, about half as long as last section of fifth, one-fifth as long as last section of fourth, and about 1.5 times as long as penultimate section of third vein.

Length, 1.5 mm.

Type, Sydney, N.S.W., October 29, 1924.

This is the only genus of the subfamily known to me which has distinct presutural bristles on thorax.

Genus Pachylophus Loew.

An Old World genus, most abundantly represented in Africa, and absent in the New World, so far as our records go. Distinguished from *Chloromerus*, which it resembles in having the hind femora much swollen and armed with spines below, by the much thickened subapical antennal arista which is densely black haired and appears about half as thick as the third antennal segment. The fourth wing-vein is very faint beyond the outer cross-vein, though traceable to margin behind wing tip.

This is the first record of the genus from Australia.

Pachylophus lutea, n. sp.

♀.—Testaceous yellow, shining. Ocellar spot, a portion of each antennal fovea, and a small spot on upper inner mouth-margin blackish. Thoracic vittae rufous, not very conspicuous; a spot on each humerus, a streak on lower margin of mesopleura, a spot on hypopleura, and the postnotum blackish; sternopleura red below. Abdominal tergites darkened basally. Wings clear. Halteres yellow.

Frons projecting as far as one-third of eye length; third antennal segment about 1.5 times as long as high; cheek fully one-fourth as high as eye. Thorax as in normal species of the genus *Chlorops*. Penultimate section of veins 3 and 4 equal, either about .75 times as long as last section of fifth vein.

Length, 3 mm.

Type, Eidsvold, Queensland (Bancroft).

The yellow colour preponderates more than in any other species of the genus.

Subfamily Botanobiinae.

Genus Thyridula Becker.

I described *Thyridula atroapicata* in a previous paper on Australian Diptera and now add another species. These two species are very similar in structure and colour so that I consider it is unnecessary to describe fully the new one and merely present a synopsis of the distinguishing characters as follows:

A. Face entirely yellow; scutellum black at apex only; hind legs yellow, the tibia slightly darker in middle; pleural spots not very large, deep black and contrasting sharply with the yellow ground colour of pleura ..... *atroapicata* Malloch.

AA. Face glossy brownish-black except on parafacials; scutellum with a broad black central stripe; hind legs yellow, femur and tibia broadly black, pleural spots very large, not very sharply contrasting with the rufous ground colour of pleura ..... *centralis*, n. sp.

THYRIDULA CENTRALIS, n. sp.

♀.—The tarsal claws of the hind legs are, as in the male of *atroapicata*, much larger than those of the other legs and very much curved, sickle-shaped.

Length, 4 mm.

Type, Sydney, N.S.W., 9.11.24.

It is possible, but hardly probable, that this is the female of *atroapicata*.

PARAHIPPELATES ANOMALA, n. sp.

♀.—Head including antennae rufous yellow, upper half of frons and the occiput fuscous, shining, but with greyish pruinescence, cheeks and face whitish pruinescent; arista fuscous. Mesonotum and scutellum glossy olivaceous black, with a quite noticeable purplish tinge, two very faint submedian lines and lateral margins broadly grey pruinescent; pleura grey pruinescent. Abdomen varying from brown to fuscous, with grey pruinescence, apices of tergites yellowish. Legs tawny yellow, mid and hind coxae, at least mid and hind femora, and sometimes fore pair also, largely blackish; same tibiae blackish except basally, apical two segments of all tarsi fuscous. Wings greyish, veins yellowish basally. Calyptra white. Halteres pale.

Ocellar bristles of moderate length; arista entirely nude; vibrissal setulae pale and weak; eye distinctly higher than long, more than twice as high as cheek. Dorsocentral thoracic bristles except the hind pair short but distinct; scutellum with basal marginal bristles shorter than apical pair, the discal hairs short. Spur of hind tibia almost indistinguishable from the surrounding hairs. The three principal costal divisions subequal; outer cross-vein about its own length from apex of fifth vein.

Length, 3-4 mm.

Type, Blue Mts., N.S.W., 15 Jan., 1922. Paratypes, Mt. Eba, S.A., north of east and west line (Campbell).

This species differs from all the others already described in having the hind tibial spur very minute, in fact in some specimens practically absent. However, it is unmistakably a *Parahippelates*. The glossy dorsum of thorax with its purplish tinge is quite distinct from the thoracic colour of any other Australian species.

It appears probable to me that *pruinosa* Thomson and possibly also *ornatifrons* de Meijere belong here. Both have four pairs of dorsocentral bristles, but neither the original describers nor Becker give sufficient details to permit of a definite opinion.

Genus EUHIPPELATES novum.

Generic characters.—Similar to *Hippelates* Loew, differing essentially in the form of the scutellum which is nearly as long as the mesonotum, about twice as long as its basal width, gradually tapered to tip, where it is about one-fourth as wide as at base, centre with a broad shallow sulcus narrower posteriorly, the sides with rather dense microscopic spinules, the sulcate portion with sparser spinules, apex with a pair of pale divergent bristles, lateral margins with much shorter pale bristles. Mesonotum with three linear sulci.

Genotype, the following species.

EUHIPPELATES PALLIDISETA, n. sp.

♀.—Head yellow, ocellar region broadly blackened and grey pruinescent, occiput similarly coloured except lower margin; antennae and palpi yellow.

Thorax black, dorsum and upper part of pleura densely grey pruinescent, lower half of pleura mostly glossy black; scutellum black, paler in centre, yellow at apex. Abdomen shining fuscous, basal and apical segments yellow. Legs yellow, all femora broadly infuscated in middle. Wings hyaline, veins yellow, the following portions blackish: costa just in front of apex of first vein, first vein on apical fourth, second vein at base below dark part of first vein, third vein from fork to just beyond inner cross-vein, fourth vein from before inner to beyond outer cross-vein, fifth vein on either side of outer cross-vein, and both cross-veins. Halteres yellow. All hairs and bristles yellow.

Frons with regularly arranged sparse short hairs, the triangle not defined; eyes almost bare; face sunken, with a sharp median carina, the antennae half hidden when face is viewed from side; arista slender, almost bare; cheek narrow. Mesonotum with four or five series of short decumbent hairs between the sulci, and three long bristles on each side on posterior margin, the inner one just laterad of the outer sulci; humeri quite prominent, well distinguished from mesonotum, each with two short bristles, both backwardly directed. Hind tibial spur fully as long as greatest diameter of tibia, situated well in front of apex. A peculiarity of the wing is that the fifth vein has no noticeable flexure near middle of discal cell (Figure 12, p. 91).

Length, 2 mm.

Type, Sydney, N.S.W., 24 June, 1924. Allotype, male, same locality, 15.10.24.

EUHIPPELATES PALLIDISETA var. PALLIPES nov.

Similar to the typical form, but the legs are entirely yellow.

Length, 1.5-1.75 mm.

Type, female, Sydney, N.S.W., 30.11.24. Allotype and one male paratype, same locality, 30.11.24 and 29.11.24.

HIPPELATES BANCROFTI, n. sp.

♀.—Head yellow; frontal triangle shining black except on its anterior and lateral posterior angles; antennae darkened only at insertion of arista, the latter and its hairs black; cheeks silvery white; palpi yellow; occiput black on upper half. Thorax shining yellow, with a black spot on middle of anterior margin well concealed by head, a rather large black spot on dorsum behind each humerus, a fuscous mark above each wing base, a black line along notopleural suture, a large subquadrate black mark in middle of hind margin which is indented on anterior side and extends narrowly over base of scutellum; pleura black along lower margin of mesopleura and on lower half of pteropleura; postnotum black. Abdomen black, basal segment yellow. Legs yellow. Wings hyaline. Halteres yellow.

Ocellar bristles cruciate; orbital setulae quite distinct; arista distinctly pubescent; cheek as high as width of palpi. Scutellum convex, almost rounded in outline, with four marginal bristles and some very fine black discal hairs; sternopleura with some fine pale hairs and a black setula above. Hind legs rather stout, spur of tibia much curved, situated before apex, about three-fourths as long as basal segment of tarsus. Veins 3 and 4 divergent at apices.

Length, 2 mm.

Type, Eidsvold, Queensland, 26 April, 1924 (Bancroft).

Distinguished by its thoracic markings from any species of the genus.

The specimen was reared from cotton bolls.

CONTRIBUTIONS TO THE CYTOLOGY AND PHYLOGENY OF THE SIPHONACEOUS ALGAE.

I. The Cytology of the Gametangia of Codium tomentosum (Stack.).

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(Forty-two Text-figures.)

[Read 27th May, 1925.]

Introduction.

The Siphonales are usually described as consisting of those Algae in which the plant body is a coenocyte or a mass of coenocytic branches. Cell walls or septa rarely appear except in connection with the reproductive organs. The plant body may assume various forms, from simple filaments, to some of the most complex forms found amongst the Algae.

Hitherto, algologists have devoted their attention to systematic work on these algae, very few records appearing of cytological investigation. Davis (1904) described oogenesis in *Vaucheria*, and in the same year Ethel S. Gepp described the sporangia of *Halimeda*. Stephens (1899) and Davis (1900, 1903, 1904) discuss the Siphonaceous Algae as a probable ancestral stock from which the Phycomycetous Fungi have been derived. Before such an hypothesis can be definitely accepted, it is necessary that further cytological details amongst the Siphonales themselves should be investigated. Further, a study of the morphology and life cycle of the chromosomes, in connection with the theoretical problem of alternation of generations, is becoming of vast importance at the present day. Yamanouchi, in 1909, drew attention to this vast field of research and the problems with which it abounds.

The classification of the Siphonaceous Algae which seems to be generally accepted at the present day is that of Oltmann. He recognizes two classes.

1. *Siphonocladiales* in which the structure is not wholly coenocytic, division walls appearing at frequent intervals along the filament. In this order are included the Cladophoraceae, Siphonocladiaceae, Valoniaceae, Dasycladiaceae and the Sphaeropleaceae.

2. *Siphonales* in which the plant body is a true coenocyte. This order includes the Codiaceae, Bryopsidaceae, Caulerpaceae and Vaucheriaceae.

This classification recognizes the Codiaceae as the most primitive member of the Siphonales. The reproduction here is the simplest found in the order and takes place either by biciliated zoospores produced in spherical branches, or by fusion of biciliated heterogametes, although zoospores and gametes are known in but few genera. The evolution of a more and more complex plant body is characteristic of the Codiaceae. The Bryopsidaceae are little more advanced. Here asexual reproduction is unknown; sexual reproduction takes place by means of biciliated heterogametes produced in lateral branches.

The Caulerpaceae produce a very complex plant body, the entire plant being coenocytic. The reproduction is so far unknown.

The Vaucheriaceae are recognized as the climax family of the Siphonales. They are freshwater forms. The asexual reproduction takes place by means of a large compound multiciliated zoospore. Sexual reproduction takes place by the union of minute biciliated spermatozoids with a non-motile egg.

The genus *Codium* was first established by Stackhouse in 1795, although the exact nature of the reproductive organs was not described till many years later. Thuret (1850) described the reproductive organs to be of the nature of zoospores produced in sporangia. Later, Berthold described two kinds of zoospores, and maintained that fusion of these was necessary before the young thallus could be formed. They were produced in the same kind of sporangia on different plants, both were of the same general form, only one was larger than the other and of a dark green colour. These he termed the macrozoospores. The others, the microzoospores, were smaller and of a yellowish colour. Since fusion occurred before germination could take place, Berthold established that the macrozoospores were the female gametes and the microzoospores the male. Went (1889) maintained that the plants of *Codium tomentosum* were dioecious, and further, he described the experiments which, he considered, proved conclusively that the macrozoospores germinated parthenogenetically without any fusion with the microzoospores. It is generally agreed that this statement requires further confirmation. Oltmann (1904) observed and figured the fusion of gametes and the subsequent development of the zygote which germinates immediately.

Codium tomentosum is a cosmopolitan species. It consists of an elongated cylindrical, spongy thallus, branching dichotomously and fixed to the substratum by means of rhizoids. The thallus consists of a densely interwoven mass of medullary filaments which give rise to numerous club-shaped palisade branches. The filaments are composed of a parietal layer of protoplasm which lines the mucilaginous cell wall and surrounds a large vacuole. In this parietal layer of protoplasm, numerous small nuclei and chromatophores are scattered. The latter are irregularly distributed through the protoplasm; usually at the base of the branches they are few, while at the apices they are usually so closely aggregated as to give a green colour of an intensity almost equal to black. This is so much so that it completely obliterates the colourless hyaline protoplasm. Usually a good deal of starch is present, associated with the chromatophores. Division walls are absent from the filaments and normally only arise in connection with the reproductive organs. It has been claimed that the coenocytic structure has been gradually attained by the formation of fewer and fewer partitions in a succession of filamentous plants.

The palisade branches are usually several times the diameter of the medullary branches which produce them. The palisade branches in their turn produce the gametangia, sometimes borne singly, but often produced in a row on either side of the palisade branch and are cut off from the latter by a plug-like wall (Text-fig. 1). As the gametangia mature, they drop off and a scar of attachment is left on the palisade branch. The writer's observations confirmed the statement that male and female gametangia are produced on different plants, i.e. the plants are monoecious.

The material for the present investigation was collected at Bondi, N.S.W. Here it grows profusely just outside the limit reached by the low tide. The material was fixed in the field in a weak chromo-acetic solution: Chromic acid

0.4 g., Glacial acetic acid 1 c.c., Sea water 400 c.c. As the plant is of such a spongy nature, an air pump was used to remove as much of the air as possible to facilitate the infiltration of the fluid. The fixative was allowed to act for about 24 hours. Material was then washed thoroughly in sea water and passed in the usual method into paraffin. Sections were made varying from 3μ to 5μ in thickness and stained, Flemming's triple stain and Haidenhain's Iron-alum Haematoxylin being employed. The latter staining process gave the better results.

Investigation.

The gametangia are of two kinds, male and female, and are produced on different plants. The male gametangia are very much smaller than the female. Both contain very dense, coarse, granular cytoplasm, in which are embedded numerous nuclei and chromatophores. This is enclosed by a wall, distinctly two-layered, the outer layer being firm and thin, the inner thick and capable of a great degree of swelling.

The gametangia are produced from the palisade branch in the following manner. A small protuberance is formed from the wall of the branch and into this a certain amount of protoplasm together with nuclei and chromatophores flows. The protuberance enlarges and the protoplasmic flow continues until a certain limit is reached, when the gametangium is cut off from the palisade branch by a thick septum. Definite evidence of this flow is recorded in the gametangium itself by the arrangement of the chromatophores, all of which have their long axis arranged almost parallel to the long axis of the gametangium, giving it a striated appearance. The nuclei, also, become elongated with their long axis arranged in the same direction. The protoplasm is evenly distributed, no vacuoles being visible from the beginning of growth. When the cross partition is formed, the gametangium is filled with colourless granular cytoplasm, nuclei, and very numerous chromatophores (Text-fig. 2).

When development has proceeded thus far, certain changes occur in the gametangia which are essentially similar in both male and female.

The gametangium at first contains numerous very small, elongated nuclei, each containing a nucleolus, a very fine linin reticulum and surrounded by a thin nuclear membrane. The nuclei once more assume a rounded form. Very soon certain nuclei commence to disintegrate; the reticulum and membrane disappear, leaving the nucleolus which stains very brightly, but finally it also disintegrates.

Co-ordinate with this nuclear degeneration, is the enlargement of certain other nuclei which are destined to undergo a heterotypic division.

A. *Mitosis in Female Gametangium.*

The nuclei as they enter the gametangium are small and elongated in the direction of flow of the protoplasm. In this condition they are more numerous at the apex of the gametangium than at its base. As soon as the dividing septum is formed, however, they lose their elongated appearance and become rounded once more, at the same time becoming more evenly distributed throughout the protoplasm. So far as the writer was able to observe, no definite number of nuclei enters the gametangium. The nuclei at this period have a thin nuclear membrane, a fine chromatin net work and a small nucleolus (Text-fig. 3). Some of the nuclei now commence to disintegrate, the nucleolus persisting till the last and then finally disappearing (Text-fig. 4). These supernumerary nuclei

have completely disappeared before the mitoses which take place in the gametangium are completed. Certain other nuclei enlarge considerably; at the same time the chromatin thread becomes very much more distinct. The nucleolus does not increase in size (Text-fig. 5). The selection of functional nuclei seems to be related to their orientation with regard to certain dynamic centres present within the gametangium. It is the nuclei in the vicinity of these centres which survive, and those further away perish. The nature of these bodies is indicated in Text-fig. 8. They are not very large, but absorb the stain with avidity so that they are easily recognizable in preparations. These bodies appear to be of the nature of dense protein centres surrounded by clear, colourless zones. Several such bodies are present in each gametangium. Observations indicated that they nourish several nuclei in their vicinity. They seem to be of a chemotactic and nutritive nature. A peculiar feature is that they are small bodies, smaller than the nuclei themselves. The bodies present to the writer very much the same structure and serve the same function as the coenocentra described by Davis (1903) in *Saprolegnia* and by Stevens (1899) in *Albugo*. The term coenocentrum, in these fungi, is applied to the centre of a coenocytic body, such a centre being connected with definite processes in oogenesis. The coenocentrum, also, is a very large structure, very much larger than the nuclei. This is precisely the reverse of the writer's observations in *Codium*. Hence, it would not seem justifiable to term these bodies, present in *Codium*, coenocentra.

As the nuclei in the vicinity of these bodies enlarge they are seen to contain a thin, ragged and much branched chromatin thread. There is no manifestation of polarity of the nucleus. Soon it becomes evident that the network is composed of very small chromatin knots connected together by irregular fibrils (Text-fig. 5). The chromatin knots become very much larger, especially those near the nuclear membrane. Co-ordinate with this, the nuclei increase in size still further; ultimately the chromatin thread is located at one side of the nucleus. This growth period of the nucleus eventually results in its becoming two or three times its original size, but as the chromatin mass does not increase at the time, it becomes left at one side, giving the typical appearance of the so-called synapsis, as indicated in Text-fig. 6. This stage forms a striking feature of the cytology of the reduction division, but appears nowhere else in the whole life history of the plant. Owing to the minute size of the nuclei it is difficult to determine the factors responsible for synapsis, but certain it is that associated with it is a considerable increase in the size of the nucleus. At the same time, the threads of the chromatin undergo considerable modification, they become very much thicker, and the general appearance seems to indicate a shortening and thickening of the threads. The chromatin thread thus becomes more sharply defined, but still has the appearance of being irregularly interwoven even in synapsis. At this stage the nucleolus may be recognized associated with the chromatin threads. Soon the chromatin threads commence to loosen, and certain of them project into the nuclear cavity (Text-fig. 7). At the same time the chromatin threads have continued their processes of shortening and thickening. The exact mechanism of the separation of the individual chromosomes could not be clearly determined. Whatever the method employed, ten pairs of bivalent chromosomes are to be observed in the nucleus in early prophase (Text-fig. 9). These are usually distributed through the nuclear cavity.

In late prophase, the nucleolus is sometimes to be observed in the nucleus in a fragmentary condition. The spindle fibres begin to make their appearance,

and attach themselves to the chromosomes, thus the achromatic spindle, with its equatorial plate, is established. The spindle is long and narrow, and its long axis is invariably parallel to that of the gametangium (Text-figs. 10, 12). A distinct membrane surrounds the spindle at this period, but on account of the minute size of the nuclei, it is difficult to determine whether this is the original nuclear membrane. If the membrane is of this nature, it would follow that the spindle would be intranuclear, but that is by no means certain. Centrosomes with radiations were not observed. Davis (1903, p. 230) notes the absence of these structures from the intranuclear spindles of *Saprolegnia*. Centrosomes may be present in *Codium tomentosum*, but the granular nature of the cytoplasm, the large chromatophores, and the avidity with which they stain, would make such minute structures difficult to determine.

The chromosomes are long rod-shaped structures, hence their arrangement on the equatorial plate is not always clear. In polar view of the various stages their number may be fairly accurately determined. The result of making a count of the number of chromosomes in the polar view of the metaphase of several hundred median sections proved them to be ten in number, but these are bivalent (Text-fig. 11). In metaphase the two halves of the bivalent chromosomes separate and pass towards the poles. Anaphase follows; the chromosomes begin to straighten out and are arranged near the poles (Text-fig. 13). After telophase, the two daughter nuclei are organized, the chromosomes lose their individuality

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Text-fig. 1.—A palisade branch bearing a gametangium and showing the scars of attachment of older gametangia (× 60).

Text-fig. 2.—Young gametangium (female) indicating the distribution of nuclei and chromatophores (× 150).

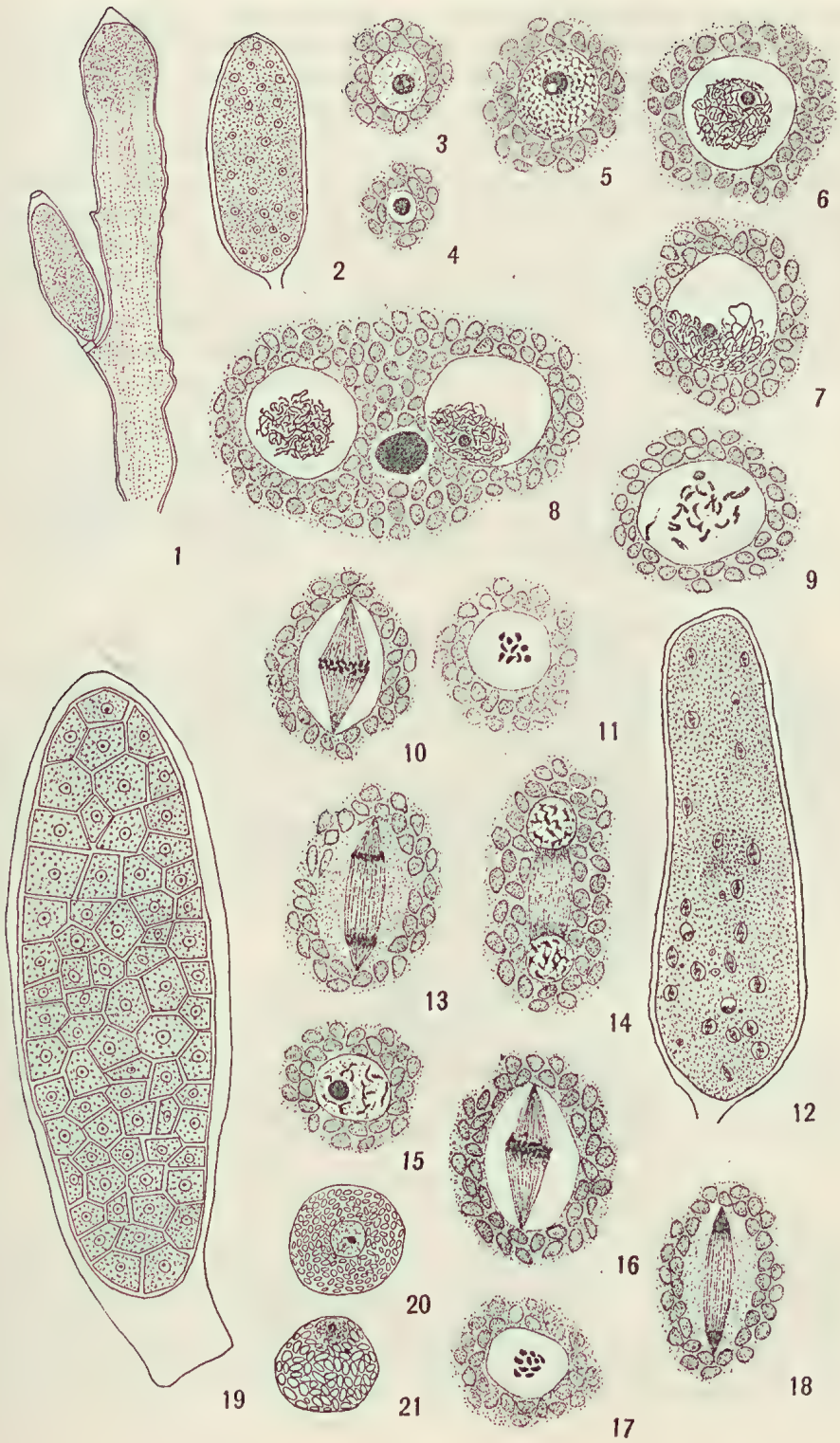
Text-figs. 3-21.—Mitosis in Female Gametangium.

3-14. First Division.

3.—This indicates the condition of the nucleus at the period of its entrance into the gametangium (× 2000). 4.—A degenerating nucleus (× 2000). 5.—A functional nucleus indicating increase in size and the nature of the chromatin reticulum which consists of granules connected together by delicate fibrils (× 2000). 6.—Nucleus in synapsis (× 2000). 7.—This indicates the loosening of the chromatin mass in synapsis, the chromatin threads projecting into the nuclear cavity in the form of loops (× 2000). 8.—This indicates the nature of the bodies which appear to select the functional nuclei. In the vicinity are three nuclei in synapsis (× 2000). 9.—Prophase: 20 chromosomes are developed and are distributed throughout the nuclear cavity, and are grouped in pairs (× 2000). 10.—Metaphase: the spindle has developed and the chromosomes are arranged on the equatorial plate (× 2000). 11.—Polar view of nucleus in metaphase indicating the presence of ten chromosomes (× 2000). 12.—A gametangium indicating the simultaneous division of the nuclei which are in metaphase. The long axes of the spindles are parallel to that of the oogonium (× 150). 13.—Anaphase: the two sets of daughter chromosomes are passing towards the poles (× 2000). 14.—The two daughter nuclei are organized and the chromosomes are losing their identity. The spindle fibres are still faintly visible connecting the two nuclei (× 2000).

15-21. Second Division.

15.—Late prophase: a number of chromosomes have emerged from the ragged reticulum. The nucleolus is still present (× 2000). 16.—Metaphase: the two sets of daughter chromosomes are proceeding to the poles (× 2000). 17.—Polar view of prophase, indicating that there are 10 chromosomes associated with this division (× 2000). 18.—Anaphase: the two sets of daughter chromosomes are proceeding to the poles (× 2000). 19.—Longitudinal section of a mature gametangium indicating the nature of the female gamete primordia (× 270). 20.—The female gamete has a rounded contour. Nucleus is in a central position (× 610). 21.—The nucleus of the female gamete has taken up a peripheral position (× 610).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and the ragged reticulum is once more established. The daughter nuclei are much smaller than the parent nucleus from which they were formed (Text-fig. 14).

After a short period of rest the daughter nuclei undergo another division, which is essentially similar, except in the number of chromosomes, to the ordinary mitotic divisions throughout the plant. In early prophase, ten univalent chromosomes are differentiated out from the ragged reticulum (Text-fig. 15). In late prophase the achromatic spindle, with its equatorial plate, is established. A thin membrane surrounds the spindle, but soon undergoes rapid degeneration. No centrosomes or radiations were observed associated with the spindle. The long axis of the spindle of the second division is also parallel to that of the gametangium. In metaphase the chromosomes divide and pass to the poles (Text-fig. 16). Where the splitting of the chromosomes occurs which provides for the second division could not be accurately determined. Anaphase (Text-fig. 18) and telophase follow, and the daughter nuclei are organized, each with its well-defined reticulum and nuclear membrane. In prophase, ten chromosomes are differentiated out in polar view, and this number remains constant throughout the mitosis (Text-fig. 17). The daughter nuclei are very small compared with the parent nucleus of the first division.

These are the only mitoses which occur in the organization of the female gametangium. They are simultaneous in all the nuclei concerned.

Text-figs. 22-35.—Mitosis in the Male Gametangium.

22-29. First Division.

22.—A functional nucleus indicating the well defined chromatin reticulum which is differentiated into granules connected together by delicate fibrils. A degenerating nucleus is also indicated here (× 2000). 23.—Nucleus in synapsis (× 2000). 24.—This indicates the loosening of the chromatin mass in synapsis; certain of the chromatin threads are seen projecting into the nuclear cavity in the form of loops (× 2000). 25.—Prophase: the chromosomes are approximately 20 in number and are grouped together in pairs (× 2000). 26.—*a*. Metaphase: chromosomes are just separating to pass towards the poles (× 2000). *b*. Metaphase: in the vicinity of the spindle is one of the structures which select the functional nuclei (× 2000). 27.—Longitudinal section of the gametangium indicating the simultaneous division of nuclei which are in this instance in metaphase (× 150). 28.—Polar view of chromosomes at metaphase indicating that they are ten in number (× 2000). 29.—Late anaphase: the two sets of daughter chromosomes are nearing the poles of the spindle (× 2000).

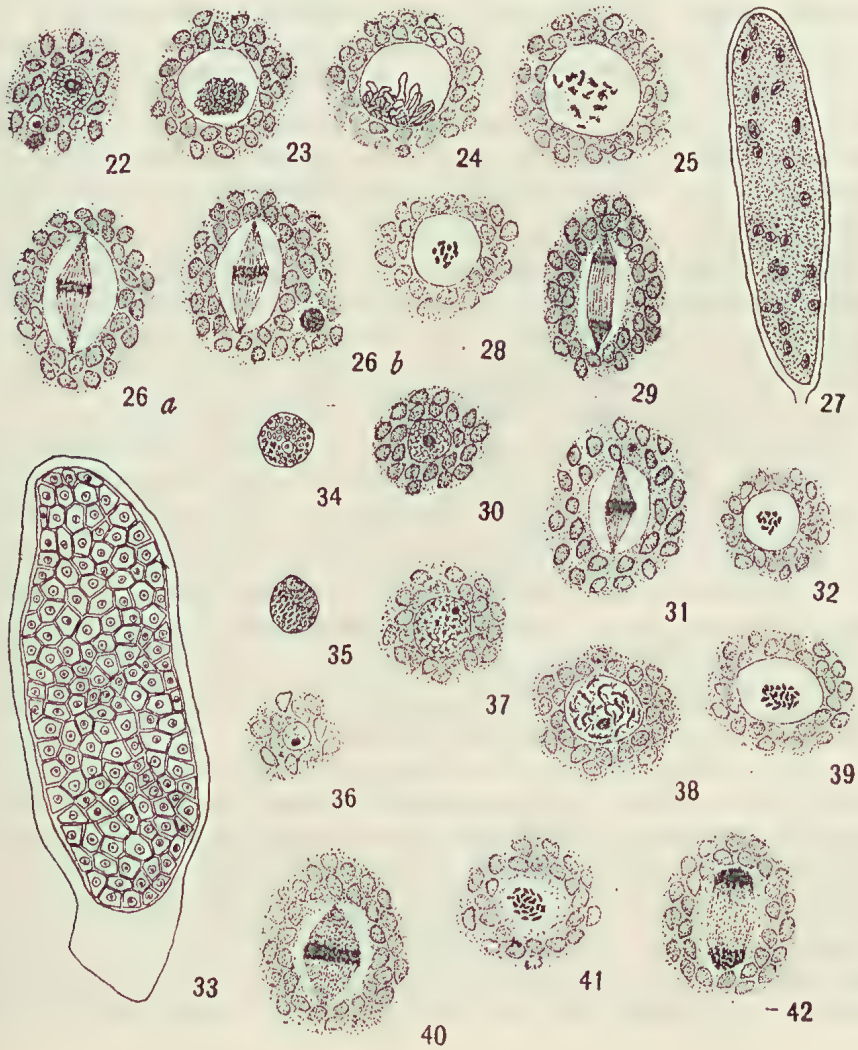
30-35. Second Division.

30.—The nucleus at the beginning of division. The reticulum is being differentiated into numerous chromatin knots (× 2000). 31.—Metaphase: the chromosomes have separated (× 2000). 32.—Polar view of late prophase indicating that ten chromosomes are present (× 2000). 33.—Longitudinal section of the male gametangium indicating the nature of the male gamete primordia (× 270). 34.—The male gamete before liberation; it has a rounded contour and the nucleus is in a central position (× 610). 35.—The nucleus of the male gamete has migrated and taken up a peripheral position (× 610).

Text-figs. 36-42.—Mitosis in Vegetative Coenocyte.

36.—A small nucleus of the central coenocytic threads of the plant indicating scarcity of chromatin material (× 2000). 37.—A nucleus of a palisade branch preparing for division; the chromatin material is more distinct, chromatin knots are being organized (× 2000). 38.—This indicates the nature of the spireme which is beginning to segment (× 2000). 39.—Late prophase (polar view); chromosomes are differentiated and are 20 in number (× 2000). 40.—Metaphase: the chromosomes are arranged on the equatorial plate (× 2000). 41.—Same as the above (Text-fig. 40) viewed from the poles, indicating that 20 chromosomes are present (× 2000). 42.—Telophase: the two sets of daughter chromosomes have reached the poles and are losing their identity (× 2000).

As soon as the daughter nuclei are formed, they separate and become evenly distributed throughout the cytoplasm of the gametangium. The protoplasm surrounding each nucleus, taking the latter as a centre of formation, becomes marked out by cleavage planes. Cell membranes make their appearance for the first time within the gametangium; each nucleus with its attendant cytoplasm is a female gamete primordium (Text-fig. 19), and becomes transformed into a single female gamete. At first, these are hexagonal in outline and fit closely to one another, but later, when ready for liberation, they separate and become rounded (Text-fig. 20). The nucleus then migrates from the centre of the gamete to a peripheral position (Text-fig. 21), and the gamete becomes pear-shaped. Cilia appear at the pointed end of the gamete in proximity to the nucleus. The gametangium opens by a pore at its apex through which the gametes escape. The liberation of the gametes is due to the shrinking of the wall of the gametangium, brought about by exposure and relaxation of pressure



at low tide. There are several hundred gametes produced in each gametangium. As there are countless numbers of gametangia produced in each branch of the plant, it follows that the gamete production is enormous.

B. *Mitosis in the Male Gametangium.*

The male gametangium is very much smaller than the female, but the processes connected with the organization of the gamete are similar in both. When the septum is formed, separating the male gametangium from the palisade branch which bears it, certain of the nuclei degenerate, while others enlarge considerably. There is an apparent marked increase in the amount of chromatin in the surviving nucleus, but no increase in the size of the nucleolus (Text-fig. 22). The nuclei which survive are those in the vicinity of certain bodies of the same nature as those described as occurring in the female gametangium. Such a structure is indicated lying close to the spindle in Text-fig. 26, *b*. Co-ordinate with the increase in size of the surviving nuclei, small granules make their appearance on the ragged reticulum, these being connected by delicate fibrils. With further increase in the size of the nucleus, the chromatin threads become eccentrically placed in the nuclear cavity, presenting the appearance of typical synapsis (Text-fig. 23). The nuclei are too minute to observe the detail of formation or structure in synapsis. The chromatin threads undergo shortening and thickening so that they are very much more distinct in synapsis than in the pre-synaptic stages. The chromatin in synapsis presents the appearance of a mass of closely interwoven threads (Text-fig. 23). Later the chromatin threads commence to loosen, and certain of them may project into the nuclear cavity (Text-fig. 24). The chromatin thread arranged in synapsis must undergo further shortening and thickening, since the chromosomes when they are formed are short, thick structures. In prophase, 20 chromosomes were counted; these were grouped in pairs, each representing a pair of bivalent chromosomes (Text-fig. 25). These chromosomes become distributed in the region of the centre of the nucleus. In late prophase the spindle fibres appear; they attach themselves to the chromosomes, and the achromatic spindle, with its equatorial plate, is established. The spindle is long and narrow; it is surrounded by a thin membrane, well defined in metaphase, but during anaphase it breaks down, disintegration commencing at the poles. No centrosomes or radiations were observed in connection with the formation of the spindle. The long axis of the spindle is parallel to that of the gametangium (Text-figs. 26, 27). In metaphase the chromosomes separate and pass towards the poles; ten chromosomes were counted in polar view of this stage (Text-fig. 28). Anaphase follows (Text-fig. 29); at telophase, the two sets of daughter chromosomes are crowded closely together and nuclear membranes are formed. The chromosomes lose their identity, and a ragged reticulum is formed; the nucleoli also reappear.

After a short period of rest, the daughter nuclei undergo another simultaneous division, similar to that which occurs in the female gametangium. There are ten chromosomes associated with the various stages of this division, as indicated in Text-figure 32, which represents a polar view of late prophase; with this reduced number the nucleus passes into telophase. The daughter nuclei are very small. The nature of this division is indicated in Text-figures 30-32.

When this mitosis is complete, cleavage planes are formed in the cytoplasm, cell membranes make their appearance surrounding each nucleus and its attendant cytoplasm. This is the first appearance of cell walls within the gametangium.

The nucleus with its attendant cytoplasm becomes a male gamete primordium, each giving rise to a single male gamete. These are at first hexagonal in outline and lie close together (Text-fig. 33), but later they separate and become rounded in outline (Text-fig. 34). Co-ordinate with these changes in the shape of the gamete, the nucleus which is originally centrally placed, moves, and takes up a peripheral position (Text-fig. 35). Cilia are developed on the side of the gamete near the nucleus. Liberation of the gamete is effected by the same means as has been already described in the female gametangium. The male gametes are very much smaller than the female and of an orange colour. Countless hundreds of gametes are produced in each gametangium.

C. *Division of the Nuclei of Vegetative Coenocyte.*

The nuclei of the coenocytic threads of the central region of the thallus are very small, in fact they are little larger than the chromatophores themselves (Text-fig. 36). They contain a small nucleolus and a scarcely visible chromatin reticulum. These nuclei are scarcely satisfactory for a study of nuclear conditions in the coenocyte. The nuclei occurring in the outer branches, especially those of the palisade branches, however, are somewhat larger. A thorough study of a typical mitosis was made in order to make an estimate of the number of chromosomes present in the vegetative body grown under normal conditions. Vegetative mitosis agrees in essentials in both male and female plants.

The nuclei occurring at the apices of the palisade branches contain a small nucleolus and a faint chromatin reticulum. In early prophase the nucleolus commences to degenerate, while the chromatin reticulum becomes very much more prominent and dispersed over the nuclear cavity. Chromatin knots become visible (Text-fig. 37), resulting in the reticulum gradually becoming transformed into a convoluted spireme (Text-fig. 38). The thin spireme thickens and later splits to form chromosomes. These become regular in size and shape (Text-fig. 39).

In late prophase spindle fibres make their appearance and numerous chromosomes are arranged on the equatorial plate. In metaphase the chromosomes split and each half proceeds towards the poles of the spindle (Text-fig. 40). The nuclear membrane is only to be observed in the equatorial region of the nucleus; in anaphase it has completely lost its identity. In late prophase and in polar view of metaphase, 20 chromosomes were recognized as being present (Text-fig. 41). They are often difficult to count on account of their number in comparison with the small size of the nucleus. It seems probable that the splitting of the parent chromosome occurs when they have become arranged on the equatorial plate. In anaphase, the two sets of daughter chromosomes proceed to the poles; telophase follows (Text-fig. 42). When they reach the poles, nuclear membranes are formed, the chromosomes lose their identity and two typical resting nuclei result.

General Considerations.

The present communication is of interest in that it indicates that alternation of generations is present associated with a fairly primitive form of sexual reproduction; the gametes are isogamous and but little removed from the asexual zoospore from which they are supposed to have been derived.

As the history of the discovery and establishment of alternation of generations among the Thallophytes has been so admirably set forth by Yamanouchi (1912), it would be superfluous to relate it here, except to quote a few

of that author's words which briefly summarize the present extent of the investigations in this direction (p. 485): "The existence of an alternation of generations among the Thallophytes, though somewhat obscure in the green algae on account of insufficient investigations, has been clearly proved by cytological study on *Fucus* (Yamanouchi, 1909), *Cutleria* (Yamanouchi, 1912), and *Dictyota* (Williams, 1904) among the brown algae, and in *Nemalion* (Wolfe, 1904), *Polysiphonia* (Yamanouchi, 1906), *Griffithsia* (Lewis, 1909) and *Delesseria* (Svedelius, 1911) among the red algae." In addition to these, Williams established the presence of an alternation of generations in *Laminaria* in 1921.

The investigation recorded in the present communication indicates that alternation of generations occurs in the life history of *Codium tomentosum*, although it is to be regarded as either a cytological alternation or as an aberrant type. The nuclei of the coenocytic threads of the vegetative portions of the plant contain 20 chromosomes. The nuclei of the gametangia, both male and female, undergo two divisions, in the first of which 10 bivalent chromosomes are present; the second division has the same number of univalent chromosomes.

There are two possibilities as to the nature of the alternation of generations in *Codium*. In the first instance, since the nuclei of vegetative coenocytic branches contain the diploid number of chromosomes, they may be regarded as sporophytic in character. The nuclei of the young gametangium (before division occurs) may be compared with the spore mother cells of higher plants (in *Codium*, cell walls do not appear separating the spore mother cells, but they are enclosed by a common membrane). Certain of the nuclei degenerate; the surviving nuclei undergo two divisions. The daughter nuclei which result from the second division may be compared with the spores of higher plants, that is, they are the beginning of the haploid generation. Still enclosed, they germinate to form the gametophytic generation. Each nucleus of this generation, with its attendant cytoplasm, by cell formation becomes a gamete primordium, each eventually becoming a single uninucleate gamete. These gametes are liberated, fuse and germinate; the sporophytic generation is once more produced. This implies that alternation of generation in this type is purely cytological with probably a primitive type of gametophyte. The main objection to this explanation is that it is impossible to determine in the haploid generation where the haploid spore ends and the gamete primordium begins.

Cytological alternation has been recorded in *Fucus* (Yamanouchi, 1909), but here the gametophytic generation, when initiated, undergoes one mitosis in the oogonium and four in the antheridium.

The second possibility is that *Codium* may be regarded as an aberrant type so far as the generally accepted ideas of alternation of generations are concerned. This may be due to the fact that the reproductive organs are primitive in character; the gametes are but little removed from the asexual zoospore from which they are supposed to have been derived. The term "sporophyte" is usually applied to that portion of the life history which contains the diploid number of chromosomes and produces the spores; these in their turn produce the "gametophyte" or the haploid generation which produces the gametes. Morphologically, spores are not produced in the life cycle of *Codium*, hence the suggestion that, since the plant produces haploid gametes directly, but is itself diploid in nature, it may be regarded as a diploid gametophyte.

The results of the investigations of many cytologists in other parts of the plant kingdom have led to the establishment of many definite facts with regard

to the phenomenon of alternation of generations. Taking these into consideration, the best explanation of its occurrence in *Codium tomentosum* seems to be that it is cytological in character, with probably a primitive type of gametophyte.

The various details accompanying gametogenesis in *Codium tomentosum* also present considerations of great interest. All the surviving nuclei in the gametangium, both male and female, are to be found at the same stage of mitosis at precisely the same time, that is, simultaneous division of nuclei occurs. This has been recorded from various parts of the plant kingdom. Stevens (1899) and Davis (1903) emphasize its occurrence in *Albugo* and *Saprolegnia* respectively amongst the Phycomycetous Fungi. Yamanouchi has recorded it in the oogonia and antheridia of *Fucus* (1909), and in oogenesis, spermatogenesis and zoosporogenesis in *Cutleria* (1912). In *Codium* this simultaneous division is of the nature of a reduction division necessary in the organization of the gametes. Nuclei of all ages enter the gametangium, so that this division not only maintains constancy in the number of chromosomes, but also serves to bring the nuclei to the one age once more.

Previous to these mitoses, degeneration of certain nuclei occurs, these nuclei representing supernumerary sperm mother nuclei.

The factors responsible for the selection of the functional nuclei are very interesting. Small granular bodies which stain deeply, and of a different nature from the ordinary cytoplasm, make their appearance, embedded in the cytoplasm. They first appear as visible structures at the period when certain of the nuclei are degenerating and others are preparing for division. It is the nuclei in the vicinity of these bodies which enlarge and undergo a heterotypic division, that is, the surviving nuclei owe their preservation to their orientation with regard to these structures. They not only nourish one nucleus in their vicinity, but several. They are not permanent structures of the gametangium, but are of a transitory nature. They appear associated with the most active periods of gametogenesis and disappear when the first nuclear division is well advanced. They represent centres of dynamic activity, their function resembling that of the coenocentra described by Davis (1903) in *Saprolegnia*, and the single coenocentrum by *Albugo* (Stevens, 1899). Their earlier appearance in *Codium tomentosum* is probably related to the differences in the processes of formation of the structures with which they are associated in these types. A rather remarkable feature in *Codium* is their small size as compared with the nuclei. Whether they are vestigial or primitive structures amongst these algae is impossible to determine.

Much interest has become centred around this region of the Siphonales (*Codium*) of recent years on account of the fact that it is these plants with simple forms of gametangia, producing uninucleate swarming spores, which have been looked to as the possible ancestors of the Phycomycetous Fungi such as the Mucorales, Saprolegniales, and Peronosporales.

It is generally agreed that the coenogamete is homologous with the gametangium. In the light of the present communication, it would seem that a further study of the nucleus of the Phycomycetous Fungi with regard to the significance of the mitoses which occur during oogenesis and spermatogenesis of these types is very desirable. Both Stevens (1901, p. 242) and Davis (1903, p. 251) consider the nuclear divisions of the oogonia and antheridia of *Albugo* and *Saprolegnia* respectively are not of the nature of reduction divisions, but are probably phylogenetic reminiscences, essential for the increase in the number of gametes in ancestral forms. Should this remark be proved to be correct, it follows that

the gametangia of *Codium*, at all events, are not homologous with the coenogametes of these Fungi, since such an homology would demand an agreement even in the details of cytology.

Summary.

1. The filaments which go to make up the plant body of *Codium* are coenocytic in structure; the nuclei of these coenocytic threads contain 20 chromosomes.
2. Gametangia are borne on the palisade branches; the plants are monoecious.
3. Certain nuclei of the gametangium (both male and female) undergo degeneration; others enlarge considerably and undergo two nuclear divisions.
4. The nuclear divisions of the gametangium are simultaneous in all nuclei concerned.
5. Selection of the functional nuclei is closely associated with the presence of a varying number of bodies, of the nature of coenocentra, within the gametangium.
6. The first of the nuclear divisions which takes place within the gametangium is heterotypic in character. Ten chromosomes are present during this division, but these are bivalent.
7. The same number of univalent chromosomes are to be found associated with the second division; hence, the daughter nuclei associated with this division contain the reduced number of chromosomes.
8. The achromatic spindles are in all instances probably intranuclear and without centrosomes or radiations.
9. The period during which ten chromosomes are present may be regarded as the haploid stage; gametophyte generation is probably a primitive type.
10. Alternation of generations in *Codium tomentosum* is purely cytological in character.

For helpful advice and criticism during the course of this investigation, the author desires to express sincere thanks to Professor A. A. Lawson, in whose laboratory the investigation was carried out, also to Dr. J. McLuckie and Mr. P. Brough.

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THE GEOLOGY AND PETROGRAPHY OF THE CLARENCETOWN-PATERSON DISTRICT.*

Part iv. Petrography.

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(Plate xxiii.)

[Read 27th May, 1925.]

Introduction.

The present paper completes the series on the Clarencetown-Paterson district. Former papers have dealt with a discussion of the stratigraphy, physiography and tectonic geology of the whole region, and also with a detailed study of the Main Glacial Beds at Seaham (Osborne, 1922, 1925). In the following pages a detailed petrographical account of the Kuttung Series is given, and some little mention is made of certain Cainozoic basic rocks which occur in small masses throughout the area. The rocks of the Burindi Series are not described, because the area of their outcrops is small and also because these outcrops are the southward continuations of large areas to the north, where important massive igneous rocks occur. It is hoped that an examination of these will be possible in the future.

The greater part of the material in the present paper is of a descriptive nature. The author feels that the time has not yet come when the broader problems of petrogenesis in connection with the Carboniferous igneous rocks can be solved, nor can much be done regarding the correlation of the Carboniferous areas to the north near Tamworth and Werris Creek with those of the Lower Hunter district. These things will only be possible after some examination has been made of the Carboniferous country between Singleton and Murrurundi—work which the writer hopes to pursue in the immediate future. Therefore in the following discussion a systematic account will be given of the rocks, taken in groups according to their identity, and some general remarks made upon certain interesting features exhibited by the rocks when considered as a whole.

It should be pointed out that in 1919 a short report on the petrology of some of the rocks from parts of the district now being considered, was made by W. R. Browne (Sussmilch and David, 1919, Appendix 2). This report, though brief, proved of considerable help to the writer in connection with his introduction to the problems of the Carboniferous igneous rocks. In fact the author wishes here to emphasize his indebtedness to Assistant-Professor Browne for his help and advice during the whole of his work on the petrology of the Carboniferous rocks of New South Wales. It must also be mentioned, that, as a result of his studies in the Gosforth-Eelah region, near Maitland, Dr. Browne has observed many facts about

* About three-fourths of the work entailed in the preparation of this paper was carried out while the writer held the position of Demonstrator in Geology, University of Sydney.

the Kuttung petrology which have not yet been placed on record by him, but which have been arrived at independently by the present author in connection with his work in the Paterson-Dungog area.

In connection with the chemical investigation of the rocks, the writer is very grateful to Mr. H. P. White, F.C.S., through whose good offices an analysis was kindly performed by Mr. W. A. Greig.

Thanks are also due to Mr. G. W. Card and Mr. C. A. Sussmilch for the loan of certain slides of the Kuttung igneous rocks.

General Discussion of Certain Features of the Rocks.

Sequence of the lavas and correlation of various sections.

The igneous rocks of the Clarencetown-Paterson district comprise a wide variety, embracing representatives of the following types: andesites and andesitic pitchstones, dacites, toscanites, dellenites, quartz-keratophyres, rhyolites and felsites. Associated with these are tuffs and flow-breccias of rhyolitic and keratophyric composition.

The question of the order of extrusion of the lavas was briefly discussed in an earlier paper (1922) and it was pointed out that a general sequence, only, held throughout the area, but modifications were found in many localities, so that the order obtaining in one district was appreciably different from that occurring in another, and it was clear that only by extremely detailed field and chemical study would one be likely to solve the problems presented by the association of calcic and alkaline rocks. The difficulties involved in examining the facts of the sequence from a petrogenetic point of view are, in great measure, due to the presence of phenomena resulting from the albitization of some or all of the original felspathic content of certain rocks, whereby their magmatic relations with other rocks, and with each other, have become obscure.

However, there is present an order of extrusion in which the following are the salient features: rocks of intermediate composition—glassy and lithoidal mica-amphibole-andesites (*a*)—are the first flows to appear; these are followed by the pyroxene-andesites (*b*) which are of greater basicity, and then comes a series of quartz-keratophyres (*c*), dacites (*d*), toscanites and dellenites and rhyolites (*e*), all more acidic than group (*a*). In this series there is considerable variation in the order of the types. If, as Browne and Walkom have suggested (1911, p. 294) the basalts (*f*) of the Permian (some representatives of which occur near Seaham) belong to, and represent the last expression of, the magma which was so active in Kuttung times, then the sequence through Kuttung and Lower Permian time would appear in a general way to represent one which was characterized, to quote Harker, by "a divergence from the initial type." And as Harker (1909) has shown for certain volcanic districts in Nevada, Mexico, and Germany, there is, in the case of the rocks now being considered, increasing acidity in the order (*a*), (*c*), (*d*), (*e*) and increasing basicity in the order (*a*), (*b*), (*f*).

It must not be forgotten, however, that there are lavas in the Burindi Series, and these should really be considered in connection with any inquiry into the petrological evolution of the igneous rocks of the Upper Palaeozoic of New South Wales, but there seems to be evidence of a substantial time break between the Burindi extrusions and those of Kuttung times, and it is quite reasonable (at all events in the Paterson-Dungog district) to look upon the extrusion of the andesites which occur towards the base of the Kuttung, as being the beginning of a subse-

quent, but more or less distinct, period in the larger volcanic cycle, which began in Burindi time. In any case, the Burindi lavas, nearest stratigraphically to the Kuttung flows, are hornblende-andesites, almost identical with those described here.

With regard to the correlation of flows over the whole area, the reader is referred to the account of the Regional Geology of the district given in the first paper of this series. There details of the relationship between certain lavas in the western areas and those in the east are given, and it is pointed out that some of the flows are characterized by the fact that they change along the strike.

In his presidential address to the Royal Society of New South Wales (1923), Mr. C. A. Sussmilch attempted to correlate certain sections at Martin's Creek and Eelah with two which had been previously described by the writer (see Sussmilch, 1923, Plate I), but certain units were linked together, which are very different as regards both mineralogical and chemical composition, and also stratigraphical position. Thus, in the Glenoak section, a quartz-keratophyre was placed as being equivalent to the Mt. Gilmore type of toscanite, and a rock which, in the Martin's Creek section, has been referred to as a dacite, but has later been described by the present author as a keratophyre, was shown as the equivalent of certain rhyolites in the eastern areas. In both cases these correlations are incorrect, and indeed it is only by the closest scrutiny of the microscopical details and field evidence that any correlation can be made wisely. On account of the peculiar features of order of succession, which the rocks under review exhibit, the present writer has been able to correlate the dominant units only.

Evidence of the Operation of late-magmatic Processes.

Albitization.—Phenomena produced in igneous rocks as a result of the activity of cognate solutions and gases acting during the last stages of, or immediately after, the consolidation of the main masses, have frequently been the subject of investigation by petrographers. One of the most important of such processes is that of albitization, whereby particularly the basic plagioclase of a rock, and at times other constituents too, become replaced by albite. Bailey and Grabham (1909) described in some detail the changes of this nature in certain Upper Palaeozoic igneous rocks of Scotland, citing other instances where albitization appears to have occurred. Many spilitic rocks have evidently been developed as a result of albitization, and Benson (1918) mentioning how Neithammer (1908) has suggested and Bailey (1911) has confirmed that many keratophyres are albitized porphyrites, summarized his own views generally that albitization by late-magmatic solutions is, at least, of quite frequent occurrence.

The article by Bailey and Grabham is perhaps the most detailed and convincing in showing how the albitization occurs and how its origin may well be connected with the magma which produced the rocks affected. Recently (1923) W. R. Browne drew attention, in a brief paper, to the occurrence of the phenomenon in many of the Upper Palaeozoic igneous rocks of New South Wales, and in the present investigation the writer has encountered numerous examples of albitization. It is thought here that the change has been one of magmatic origin, produced by solutions connected with the extrusions of the lavas, and after a description of the phenomenon, the reasons for this view will be given.

In the rocks examined the replacement is found in non-vitrophyric types. Thus the well known pitchstones occurring towards the base of the Kuttung Series are immune from albitization. The more basic of the lithoidal types are also free from the change. In those lithoidal types affected, both plagioclase and ortho-

clase may suffer replacement, whether they be phenocrysts or in the groundmass, although in the case of the latter it is difficult to make out the extent of the change satisfactorily.

In general the albite attacks the phenocrysts by working along the cleavage cracks and around the margins. At times the plagioclase phenocrysts may be undergoing change without reference to any optical directions, and in such a case, had conditions permitted, a complete pseudomorph would have resulted. At other times, however, a particular zone or zones in the plagioclase may be albitized while the rest of the mineral is unaltered; in such cases, the more basic zones suffer. Frequently a little calcite is found associated with the albite, and in almost all cases there are scales of sericitic mica, which may be the result of normal weathering of the albite itself. How far the calcite may represent the residual lime left after replacement is not clear.

One characteristic of the secondary albite is its spongy appearance, due possibly to the aggregation of tiny patches of albite which, though probably in optical continuity, are mixed with a certain amount of impurity and possibly with ultramicroscopic areas of residual basic plagioclase.

In the change of orthoclase to albite, the ragged outline of the albite working from the margin across the crystal is very characteristic, and often the albite has a dirty yellow colour in ordinary light, which may be due to the presence of some limonitic material.

The groundmass of certain rocks, when cryptocrystalline, shows a certain amount of replacement by albite which occurs in short prisms, and when pumiceous the ground may show a kind of selective albitization, the cusp-shaped bodies being partially or wholly replaced.

In some cases one can find sufficient unreplaced material to permit the determination of the original composition of the lime-soda felspar, but at times the albitization has, as far as can be seen, been complete, and the consequences of such a circumstance are very important, especially in connection with the question of the relations of the various rocks.

That the process of albitization in these rocks has been of magmatic origin, as specified above, seems to be established from the following criteria: The change has been selective, affecting those rocks which are at least as acid as the Martin's Creek andesite. The lithoidal pyroxene-andesites, which are the most basic in the series, have not been altered in this manner. In regard to the immunity of the glassy andesites from albitization, it is not thought that this point has any significance in connection with the origin of the phenomenon, because, whatever the nature of the solutions involved, it is probable that these glasses offer little means of access for the waters, but in the case of the lithoidal pyroxene-andesites, they, being in direct association with albitized rocks, should likewise show evidence of having been affected, if the solutions were meteoric.

Then again, the extent of the phenomenon does not in any way correspond with the extent of atmospheric weathering seen in any of the albitized rock masses, nor is the albitization to be found more complete near cracks and fissures. For example, in very fresh specimens taken from the deepest portions of the quarries in the andesite at Martin's Creek and the keratophyre on the Williams River below Clarencetown, the albitization is quite well-developed, being in the latter case such as to have replaced completely the original lime-soda felspar. Also, in rocks which are strongly albitized there is often an absence of the effects of weathering in the minerals.

Further, there is an almost constant association of chlorite with the albite, and it is difficult to imagine how chloritization of plagioclase, and even of orthoclase, as in one or two instances, would be brought about by meteoric solutions.

Thus the process of albitization in these rocks seems to be of magmatic origin, occurring after the consolidation of the lavas, but being the effect of the operation of solutions directly connected with the lava magmas. That is to say, the process is a "deuteric" one as defined by Sederholm (1906) and its origin is indicated by the term "late-magmatic" as used recently by Browne (1925). Holmes's definition (1920) of Sargent's term "autometamorphism" (1917) would also include the process of albitization.

Chloritization.—The occurrence of chlorite in certain of the Kuttung rocks is such as to place doubt upon its origin being simply connected with weathering. Thus in certain andesites and toscanites, a replacement of plagioclase by chlorite occurs, the latter confining itself to one or more zones, and rarely completely replacing the former. Elsewhere in the groundmass of these rocks, patches and veinlets of chlorite are found undoubtedly indicating selective replacement. In all cases of the presence of chlorite in the manner indicated here, albitization was found to have occurred. Bearing in mind the chemical composition of the chlorite minerals, and having regard to the constant association of albitization and chloritization, it seems reasonable to regard the former as being, like the latter, of late-magmatic origin.

Kaolinization.—In various rocks throughout the Kuttung Series, kaolin occurs in notable amounts replacing felspar phenocrysts and also groundmasses which originally have been pumiceous and glassy. In many cases the field evidence is somewhat against the kaolin having been produced by the action of surface waters, although it must be understood that there are numerous cases where it is clear that the kaolin has developed by rock decomposition. Of the former cases, two can be cited. In a quarry near Seaham, specimens taken from about fifteen feet below the ground level show much more kaolinization than those close to the surface, and separating the kaolinized rocks over an appreciable extent is a band higher up, which has a groundmass in which kaolinization is almost absent. In the case of the Williams River keratophyre quarry, one finds a greater proportion of kaolinized felspar as one proceeds downwards, and the kaolinization is sometimes sporadic in occurrence, and found not close to joints.

This field evidence, then, seems to suggest that the kaolin has been produced by the action of magmatic solutions, and in support of this one finds that albitization and chloritization are often associated features.

That kaolin may be of deuteric origin seems to be demonstrated by certain features exhibited by the Prospect intrusion (see Browne, 1925), and it occurs in some rocks on the South Coast of New South Wales in such a way as again to indicate origin by the action of late-magmatic waters.

Devitrification, and the Relation between the Glassy and Lithoidal Andesites.

From the petrographical examination of the rocks it is clear that devitrification has occurred in a large number of cases. Thus, pumiceous material, originally glassy, has been affected and altered into material with cryptocrystalline texture. One can frequently see unaltered patches of pumiceous matter in a rock which has not undergone complete devitrification. This residual glassy content is different from that occurring as streaks in some rocks, such as the

Martin's Creek andesite, where it appears that the glass is a fraction that did not have an opportunity to crystallize like the bulk of the rock. Then, in certain instances, it was noticed that some lithoidal rocks showed a sort of perlitic cracking, which almost certainly occurred during the rapid solidification of a glassy rock.

The question of the time of devitrification is one of interest and of some difficulty. Judd (1889) described processes which had operated in rocks with vitrophyric groundmasses whereby phenocrysts actually enlarged themselves at the expense of the glass, the process being a kind of devitrification, regarded as secondary, but occurring at no great time after the congealing of the lava. In describing the origin of the pitchstones of Mull, Anderson and Radley (1917) showed by chemical evidence that the lithoidal rocks appeared to be the devitrified products of the pitchstones. These authors distinguished between primary and secondary devitrification, the former occurring just after the consolidation of the rock and the latter being a long process working for ages after solidification.

Bonney and Parkinson (1903) described two types of devitrification, one primary and one secondary, but in giving detailed descriptions of each of these, did not explain clearly their time relations, although Bonney elsewhere (1885) has indicated his belief that the primary devitrification occurred during cooling and the secondary type took place long afterward. Harker (1909, p. 226) did not agree with those who postulated primary and secondary devitrification, and inclined to the view that it was a process of long duration. In the case of the Kuttung lavas there is little evidence available to help one to decide when the change occurred, but in view of the fact that certain authors have maintained that so-called primary devitrification occurs immediately following the consolidation of a glassy rock, it might be worthy of consideration whether the change has, in the Kuttung lavas at all events, had some relation to the activity of late-magmatic solutions. The possibility of a lava being devitrified would then depend to a great extent on the chemical composition and the physical conditions attending its cooling, and thus it would be reasonable to expect to find certain glassy rocks practically wholly unaffected, in association with lavas evidencing devitrification, an association which occurs in the Kuttung terrains.

This discussion of devitrification leads us to enquire into the question of whether the lithoidal varieties of amphibole- and pyroxene-andesites are the devitrified equivalents of the glassy andesites, which are found in close association with them, and which, mineralogically, are in each case similar.

Anderson and Radley demonstrated that the felsites of Mull were chemically very similar to the pitchstones, except as regards the content of combined water, and were convinced that the former had arisen from the latter by the escape of some of this water. The chemical evidence in the case of the hornblende-biotite-andesites now being considered does not support the view that they have been derived from glassy andesites by devitrification. This may be seen from the chemical data given below:

	I.	II.
SiO_2 ..	64.88	66.38
CaO ..	3.00	4.11
Na_2O ..	5.41	3.55
K_2O ..	2.79	1.72
H_2O ..	1.63	4.56

I. Biotite-hornblende-andesite, Martin's Creek.

II. Hypersthene-bearing biotite hornblende andesitic glass, Tumbledown Creek, east of Martin's Creek. Analyst G.D.O.

Of course, the wide variation in the case of the values for soda is to some extent due to the fact that albitization occurs in No. I, but the difference in the values of potash is too marked to allow of No. I being the devitrified product of No. II. Chemical examination of the two phases of the pyroxene-andesite has not been made, but the association of very similar rocks at Currabubula has been commented upon by W. R. Browne (1920, pp. 415-6).

Concerning the field evidence it is to be pointed out that the two varieties of the biotite-hornblende-andesite were always found to be sharply bounded. Thus in a railway cutting to the east of Wallarobba, there is the following succession: lithoidal andesite 6 feet, glassy andesite 2½ feet, lithoidal andesite 12 feet; all the bounding surfaces being sharply defined.

In the case of the hypersthene-augite-andesite one was not able to delimit in the field the extent of the two phases, but it appeared as if there were separate flows of the two varieties.

Microscopically there does not seem to be much in favour of the lithoidal andesites having been derived from the glassy types. Thus in the case of the pyroxene group, the groundmass of the stony phase is spongy in appearance, and under crossed nicols with high magnification there are no signs of residual glass. Also in the lithoidal phases of the mica-amphibole-andesites there are present streaks, rather than patches of glass, strung out in the direction of flow which, in the writer's opinion, indicate original heterogeneity of the magma material at the close of the intratelluric crystallization.

Mineralogical and Magmatic Relationships.

The effect of late-magmatic processes upon many of the rocks has made a consideration of their relationships a matter of difficulty, but in spite of this, one can see to some extent how the various lavas are genetically connected from a mineralogical point of view, while a satisfactory understanding of their magmatic relations is not possible with the data at present available.

Mineralogical Relationships.—Although quartz has been noticed in the Martin's Creek type of andesite, it is doubtful whether it really belongs to the rock, probably being xenocrystic. This mineral makes its appearance in the quartz-keratophyres and dacites, increasing in importance in the toscanites, till in the dellenites and rhyolites it is conspicuous. In some cases it is present in the groundmass of certain acidic rocks.

Plagioclase, where unaltered, shows a gradation from labradorite in the pyroxene-andesites to andesine in the mica-amphibole-andesites and toscanites, becoming acid andesine and oligoclase in the dellenites. It is not clear whether any primary albite occurs in the soda rhyolites.

Orthoclase is very subordinate in the dacites, but becomes an important constituent in the toscanites and dellenites, and its further increase is seen in the sodipotassic and potassic rhyolites.

Of the ferro-magnesian minerals, biotite is the most widespread, being found in all groups of rocks except the pyroxene-andesites, and hornblende is also fairly widespread, being present in the Martin's Creek type of andesite, the Williams River keratophyre, in some of the dacites, and in both the Mt. Gilmore and Paterson types of toscanite and andesite, as well as in certain rhyolites.

Augite and hypersthene have their best development in the pyroxene-andesites, but both occur along with biotite and hornblende in a glassy andesite from

Portion 99, Parish of Barford; this rock being a connecting link between the two main groups of andesite.

The iron ores in the rocks comprise magnetite and ilmenite. Often both are present, whereas one or other may occur alone. In this connection ilmenite is especially characteristic of the dacites.

Apatite is of almost universal occurrence, but it is of greater abundance in those rocks which contain considerable ilmenite. Zircon is of quite frequent appearance in the hornblende-andesites, but only occasionally met with in some of the other types.

Chemical Relationships.—With the data to hand at present, and in view of the presence of albitization, one cannot achieve much in the way of examining the magmatic relations of the rocks under discussion.

The salient features of the chemical evidence are as follow: The rocks which have been analysed show fairly high silica percentages, even in the case of the rocks with andesitic characters. Thus the andesites contain from 64.88% to 66.38% of silica, the quartz-keratophyres and dacites about 67%, and the dellenites, which are closely allied to sodipotassic rhyolites, have as much as 72% or 73%. Concerning the alkalis, potash has been found as an important constituent in all rocks analysed. Indeed it would appear that, were it not for the presence of albitization, it is probable that the Kuttung rocks in this district would show a general possession of a sodipotassic or in some cases a "dopotassic" character.

Magnesia is low in most rocks, although it would probably be found to be fairly important in an analysis of the pyroxene-andesite. A fair amount of titanium and also appreciable amounts of manganese are always present, while phosphorus varies considerably, sometimes being only present as a trace.

What was the composition of the original magma, from which the Kuttung lavas were derived, is a question which it is difficult to answer. Chiefly from field evidence, strengthened by a consideration of the chemical and microscopical data, one must say that the suggestion put forward by Dr. Browne that the hornblende-andesites may represent the composition of the original magma which later became differentiated into divergent types, does seem to be likely to prove correct.

Spherulitic and Allied Structures.

In the groundmasses of some rocks examples of spherulitic crystallization are found. The spherulites are often very minute and in general have never been found to attain any great size as is the case in certain volcanic rocks in various parts of the world. Sometimes there are present structures of the same nature as the spherulites, but these are not always circular in cross-section, representing rather growth from a series of points linearly disposed. Among the most frequent of such structures are some which may be called axiolites, being very similar in structure to those figured by Iddings (1910, p. 240). Often the spherulites are aggregated together so as to form an integral part of the rock, but at other times these aggregations may be present as inclusions. Examples of the latter cases are to be found in a felsite occurring to the east of the Railway Line about one mile south of Martin's Creek. *Specimen 26** from this locality shows an abundance of inclusions, many being entirely composed of aggregations of spherulites and axiolites, the spherulites averaging ¼ mm. in radius. They are

* Numbers refer to specimens in the writer's collection.

set in a groundmass which is somewhat kaolinized and haematitized. Under the microscope, the material composing the spherulitic structures is, for the most part, felspar which has a refractive index less than that of Canada balsam, but there is also some silica in association with the felspar.

With regard to the time of development of these structures, it is to be pointed out that in some of the rhyolites the spherulites are found across the flow lines. This may mean either that the spherulitic crystallization occurred after consolidation of the material showing the flow structure, or, at all events, after this material became too viscous to move. Although the latter seems the more probable, Harker mentions (1909, p. 275) cases of the former.

Judd also (1889), described certain pseudo-spherulitic structures, which he considered developed after the solidification of the rock, while Parkinson (1903), in discussing Iddings's work on the Yellowstone Area (1885-86 and 1899), contends that there may be more than one period of spherulitic crystallization in a glassy rock, some spherulites developing before the perlitic cracking which is often characteristic of obsidians, and others appearing after the consolidation of the glass when its perlitic cracking was complete.

Autobrecciation.

A feature of many of the Kuttung lavas of acid alkaline composition is the presence, in the groundmass, of brecciated structures which have originated during the solidification of the mass. This type of structure has been termed autobrecciation. The effects of its operation on a fairly large scale are to be seen in the features exhibited by certain flow-breccias in the Langlands section which have been described in a former paper (1922, p. 173).

The autobrecciation has been observed only in the acid lavas and especially those which are sodic. It is clearly related to the high viscosity of such magmas, and has been commented upon by a number of authors. Woolridge has described the petrography of an interesting set of rocks from Llanwrytd, Wales (Stamp and Woolridge, 1923), which are dominantly sodic, and he has emphasized the prevalence of pyroclastic material and the existence of autobrecciation. These rocks are of terrestrial origin and it would seem that subaerial conditions should be favourable to the production of brecciated structures in acid sodic lavas, by the breaking up of a magma crust and the subsequent corrosion of the fragments in the residual molten material. But J. F. N. Green (1919) argues that autobrecciation is a feature of submarine flows of certain chemical composition.

Associated with the Kuttung lavas showing evidence of autobrecciation is the occurrence of flows in which there is an abundance of vesicular glassy material, often now devitrified.

Petrographical Descriptions of the Kuttung Series.

Nomenclature of the Rocks.

Before proceeding with the petrographical details, it is pertinent to say something about the nomenclature of the rocks. As has been pointed out above, the process of albitization, whereby felspars and other material become replaced by albite of late-magmatic origin, has affected many of the rocks and in some cases obscured their relationships. In the cases where the albitization has been partial, the original identity of the rocks is often determinable, but when the change has been complete, with reference to the primary felspars, there is

generally no clue to the original nature of the rocks and they have to be referred to as soda rhyolites or keratophyres. It has been decided, therefore, in the case of the altered rocks to name the rock according to its original identity where possible, and to mention the possibility of a rock having had its felspathic constituents completely albitized, where such is suspected, the rock in such case being named according to its present constitution. Attention has been drawn by W. R. Browne to the difficulties arising out of the albitization of igneous rocks (Browne, 1923).

Then, concerning the acid and sub-acid lavas, one has had to make use of the terms dellenite and toscanite for the following reasons: There are a large number of massive igneous rocks in the Kuttung series which possess considerable variety and which might all come under the two broad categories, rhyolite and dacite. To apply either of such terms to numerous rocks, however, would be impracticable in connection with the present petrographical discussion, since fine distinctions between important flows would not be recognized, and confusion would result. The use of the terms toscanite and dellenite (both very much the same as quartz-trachy-andesite, but each much shorter and more serviceable) permits the recognition of very slight gradations in chemical composition: thus the term toscanite has been applied to rocks where there is a fair amount of orthoclase, as well as considerable plagioclase which is basic andesine or acid labradorite, and the term dellenite applied to types where there is orthoclase, and plagioclase of the composition oligoclase or very acid andesine, quartz in both instances being dominant but not very excessive. The increase of quartz and the absence of orthoclase, always accompanied by an acidification of the plagioclase, produces a soda rhyolite, and the greater abundance of orthoclase places the rocks in the category of potash rhyolite. In connection with those rocks dominantly sodic, the name keratophyre has been applied to rocks which show much phenocrystic albite with stout prismatic habit, and a sort of coarse orthophyric fabric, or an approach thereto. Soda rhyolite has been reserved for acidic albitic rocks which have extensive cryptocrystalline groundmasses.

In the following descriptions the dominant types in each section will be considered in detail, the less important representatives being treated only with reference to their variation from the main types.

The distribution of the various types described below has already been indicated in the former paper and will not be repeated here.

Andesites.

The andesites comprise two fairly distinct groups, characterized by biotite and hornblende on the one hand, and augite and hypersthene on the other. There are also some rocks which act as connecting links between the two series, in that they contain both amphibole and pyroxene. In each of the two main groups there are glassy and lithoidal varieties.

Mica-amphibole Group (Martin's Creek Type).

Glassy Varieties.

Megascopical characters: These rocks are black in colour, with a resinous lustre, possessing phenocrysts of felspar and biotite and a number of yellow streaks.

Microscopical characters: *Specimen 80*, from the Railway Cutting three-quarters of a mile east of Wallarobba Station, shows the presence of hornblende, plagioclase and biotite and very subsidiary pyroxene, apparently hypersthene, also

apatite and magnetite set in a groundmass which is almost entirely glassy. The felspar individuals are fresh but cracked noticeably, and possess a tabular habit and a composition close to Ab_3An_2. The hornblende is quite fresh and shows the (110) cleavage rather well, while biotite, although fairly well-formed, evidences bleaching and some alteration. One or two sections of quartz may be of xenocrystic origin.

The vitrophyric groundmass shows fluidal fabric and is noticeably cracked as a result of pressure following solidification. There are present a number of microlites of felspar and tiny magnetite crystals as well as small patches, which under high magnification appear to be greenish decomposition products.

Lithoidal Varieties.

Megascopical characters: These rocks vary in colour from light blue and grey to dark blue. Phenocrysts of hornblende and plagioclase, the latter often showing a black core, occur in varying amount in a dense dull-lustred groundmass which possesses some reddish blotches. The rocks fracture in various ways, according to the nature of the texture and mineralogical arrangement.

Microscopical characters: *Specimen 1*, from the quarry formerly owned by the State Metal Quarries, Ltd., shows the following primary minerals present: plagioclase, hornblende, biotite, magnetite, ilmenite (?), apatite and zircon. These are set in a groundmass which makes up two-thirds of the rocks.

The plagioclase has the composition Ab_3An_2 (andesine) and possesses a tabular prismatic habit. It is occasionally zoned and the grainsize is variable and up to 2 mm. in diameter. Albite, carlsbad and pericline twinning are all present, the last of these being rare. Albitization and chloritization (see Plate xxiii, No. 2) of the andesine have occurred and scales of sericite have developed by decomposition, but these features are not present to the extent of obliterating any one grain. The albite has used the imperfect cleavage cracks to facilitate its attack upon the more basic material, and in some cases has replaced the central portions of the andesine first of all. The chlorite is found pseudomorphing the core of the plagioclase in most cases, while at other times it has selected some zone or zones which are completely replaced.

Hornblende occurs subidiomorphically and shows a fair amount of resorption. The cleavage parallel to (110) is well developed and the pleochroism is strong. Biotite, which is present in slender pieces, is very much altered by chloritization and has been resorbed with the production of magnetite.

Primary magnetite certainly occurs and there seems to be some ilmenite also. The apatite and zircon call for no special remarks, except to point out that the latter is subordinate to the former. Quartz occasionally occurs in this andesite, but under the microscope appears to be of a xenocrystic nature. The field evidence, however, shows that towards the base of the andesites at Martin's Creek the number of quartz individuals increases.

The groundmass shows lines of flow very well and consists of streaks of brownish glass and patches of cryptocrystalline material. It would appear that this glassy matter is the expression of original heterogeneity of the magma, rather than that partial devitrification has occurred. The red patches referred to above are due to staining by haematite derived from nuclei of iron oxides.

Specimen 2 is somewhat lighter in colour and shows more phenocrystic hornblende than does *No. 1*. In thin section it is similar to *No. 1*, but there are some completely albitized phenocrysts.

Specimen 3 differs from *No. 1* in that the ratio of groundmass to phenocrysts is smaller, and there is a coarser grainsize in the microfelsitic portions of the groundmass.

Specimen 4 is of a dark blue colour and possesses a very irregular fracture. The plagioclase individuals are ill-formed, and there is an almost entire absence of hornblende. Microscopically, it is seen to differ widely from the other varieties. Glassy material is almost absent from the groundmass and the spongy felspathic content is of a coarser texture than has been the case hitherto. The phenocrysts of andesine are somewhat replaced by albite and chlorite and are ragged in outline. Apatite and zircon are quite distinct.

It may be mentioned here that in his account of the Martin's Creek andesite, M. Aurousseau (1915) recorded the presence of hypersthene. The present writer has not observed this mineral in any of the many slides of the andesite which he has examined.

Pyroxene Group.

Glassy Varieties.

Megascopical characters: These, in hand specimen, are black rocks possessing a subdued resinous lustre and a fair amount of yellowish-coloured plagioclase as phenocrysts. A little ferro-magnesian material is also discernible.

Microscopical characters: Phenocrysts of plagioclase, hypersthene, augite, magnetite and apatite are set in a brownish-grey glass. The plagioclase is tabular in habit and shows twinning according to the albite, carlsbad and pericline schemes. There is a little zoning present, and many inclusions are seen. Some of the inclusions are arranged zonally and may consist of portions of the groundmass, yet the edges of the felspar are not corroded to any extent. The composition of the mineral is that of basic labradorite. The (001) cleavage is only poorly developed in some individuals. Very noticeable is the absence of albitization and chloritization. Hypersthene is more abundant than augite and shows fairly distinct pleochroism, a fairly-good cleavage and the presence of numerous cracks. Magnetite is generally found as inclusions in the hypersthene. Felspar inclusions are rare and apatite only occurs occasionally. The hypersthene is only slightly altered and then to a brownish-green silicate, possibly anthophyllite. The augite is subidiomorphic, up to 1½ mm. in diameter, and possesses twinning, being of a brownish-grey colour.

The groundmass is almost entirely glassy, but under the high magnification is seen to include a number of tiny patches of a greenish substance, which is probably derivative from a ferro-magnesian mineral, and some tiny felspar crystals, the remainder being brown glass. In one slide there was present what appeared to be an inclusion of a rock, essentially similar in composition to the host, that is to say, composed of augite, hypersthene and plagioclase, possessing an even grainsize and showing no decomposition. This probably represents a cognate xenolith which has been torn by the magma from some mass which crystallized under intratelluric conditions.

Lithoidal Varieties.

Megascopical characters: These varieties are dark blue to black in colour, the felspar phenocrysts being very readily seen and the pyroxene only with difficulty. The groundmass possesses a dull lustre.

Microscopical characters: In thin section one sees the same phenocrystic constituents as in the glassy varieties. The felspars are tabular in habit and

variable in grainsize, the maximum being about 3 mm. in diameter. Zoning, and twinning according to the albite and carlsbad schemes, are present and the composition of the plagioclase is Ab_2An_3, labradorite. Hypersthene is noticeably changed, the alteration developing around the margin of the grains in the first place and then along the cracks. The product seems to be something related to uralitic hornblende. Augite is not very conspicuous and is quite fresh. Apatite is present in acicular crystals.

The groundmass is distinctive in its appearance and consists of a spongy mass that extinguishes in patches on rotation of the microscope stage. There is not the felsitic appearance which characterizes so many of the groundmasses of the other Kuttung rocks. Examination of this groundmass under the high power shows the presence of tiny green patches which clearly are pseudomorphs, together with abundant iron ore individuals all set in a felspathic mass which shows undulose extinction. There is no glass present, and in a general sense the groundmass is not heterogeneous.

Amongst the pyroxene-andesites there is very little variation within the two groups and foregoing descriptions hold for almost all the occurrences in the area.

Transitional Types of Andesites.

Intermediate in character between the amphibole- and pyroxene-andesites come certain rocks of limited distribution; *Specimen 327*, from the northern side of a ridge in Portion 99, Parish of Barford, is typical of these rocks.

Megascopical characters: This is a greenish-black rock with a greasy rather than a pitchy lustre. Phenocrysts of hexagonal biotite and another ferro-magnesian mineral are clearly seen, also some tiny laths of felspar.

Microscopical characters: In thin section one sees phenocrysts of plagioclase, biotite, hornblende, augite, hypersthene, and quartz set in a glassy groundmass, which contains a few felsitic inclusions. The rock shows a certain amount of cracking and there is also marked flow structure. Some of the phenocrysts are shattered as a result of pressure acting after the rock consolidated. The plagioclase, which is acid labradorite, shows a tabular habit, and albite and carlsbad twinning. Hypersthene is not abundant and is non-pleochroic, but shows alteration to a greenish substance. The augite is present in small equidimensional crystals and is fairly fresh, being of a grey colour. Hornblende is a fairly important constituent and shows the prismatic cleavage fairly well developed. Pleochroism is noticeable and decomposition is practically absent. The biotite is both bent and bleached at times, but it has not been resorbed. The quartz appears to be xenocrystic in origin, in view of the fact that it generally shows an association with a certain amount of cryptocrystalline material, which is quite similar to the groundmass of the included fragments, but unlike the glassy groundmass of the main rock. It is to be noted, also, that in one slide of these rocks quartz was almost absent and so also were the rock inclusions. The groundmass of *327* is brownish in colour and almost completely glassy.

Chemical composition: A chemical analysis of *Specimen No. 1*, a lithoidal andesite from Martin's Creek and also a partial analysis of *Specimen 327*, a transitional type of glassy andesite, were made. These are tabulated below together with an analysis of another specimen of andesite from Martin's Creek, quoted by Mr. Sussmilch (1923, p. 24).

It will be seen immediately that in analysis No. I there is evidence of the rock having been albitized. The composition of the plagioclase calculated from the chemical data comes out at about oligoclase of the formula Ab_4An_1, while the unaltered felspar seen in parts of the rock under the microscope was andesine of the composition Ab_3An_2. In the case of analysis No. III there is evidence that the albitization has been less extensive. The figures for the rock from Tumbledown are of interest, showing the high content of combined water, and values for lime and the alkalis which are more normal for an andesitic rock. These circumstances are due to the fact that late magmatic processes have not affected the rock. From a determination made upon the alumina of this pitchstone it was quite clear that there was sufficient present to allow all the lime to be calculated as anorthite, and with this information the plagioclase felspar in the rock has been found to be of the composition Ab_3An_2, this being about the same as that of the unaltered plagioclase in the lithoidal andesite (*Specimen 1*).

	I.	II.	III.
SiO_2	64.88	66.38	64.20
Al_2O_3	16.18		16.88
Fe_2O_3	1.52		1.90
FeO	2.43		2.52
MgO	1.21		.66
CaO	3.00	4.11	3.14
Na_2O	5.41	3.55	4.41
K_2O	2.79	1.72	3.52
H_2O+	1.63	4.56	1.79
H_2O-	.50	1.04	.31
TiO_2	.89		.65
P_2O_5	trace		.13
CO_2	trace		.03
MnO	.05		—
	100.49		100.14

Specific gravity of I = 2.642 at 16.5° C. Magmatic name for I = Lassenose.

I. Andesite, lithoidal variety, *Specimen 1*, Martin's Creek, N.S.W. Analyst, G. D. Osborne.

II. Andesite, glassy variety, *Specimen 327*. Tumbledown Creek, near Martin's Creek, N.S.W. Analyst, G. D. Osborne.

III. Andesite, Martin's Creek. Analyst, W. G. Stone.

Dacites.

Megascopical characters: The dacites are in general of a light colour, chiefly pink and cream, although darker varieties occur in the neighbourhood of Glenoak. The fracture of the rocks is generally very even, but becomes quite irregular in those types which contain a number of inclusions and spherulitic structures. The

minerals visible in hand specimen comprise plagioclase, quartz, biotite, and sometimes orthoclase. At times the former two are very conspicuous and at other times they, as is generally the case with the latter two, are quite inconspicuous. The lustre of the rocks is dull, the appearance of the groundmass quite felsitic. The inclusion-bearing types are, like the massive rocks, of fairly wide distribution, but a notable occurrence of the former is near the foot of Mt. Johnstone, about 1¾ miles from Paterson. Here one finds a great variety in the appearance of the dacites, although the parent rock is fairly constant in composition.

Microscopical characters: The minerals discernible under the microscope comprise quartz, plagioclase, biotite, orthoclase, ilmenite, magnetite, hornblende, zircon, and apatite. The plagioclase varies considerably in grainsize, being up to 1½ mm. in diameter. The twinning is chiefly according to the albite law, but sometimes after the carlsbad law as well. The habit is generally tabular, but at times almost prismatic. The chemical composition of the felspar varies from basic oligoclase to very acid labradorite. Decomposition to kaolin has progressed to a fair degree in many cases, and fresh felspars are rarely to be seen. Some replacement by albite, almost certainly of deuteric origin, is common and may have occurred to the extent of half the original crystal being replaced.

Quartz is generally cracked and corroded, but always shows sharp extinction. It varies considerably in grainsize and when in the groundmass is very small indeed. Orthoclase, of course, is only of infrequent occurrence and then in a very subordinate amount. There is generally a good (001) cleavage present, and almost complete kaolinization is always to be seen.

Biotite is fairly common in one or two slides, but sparingly present in the majority. Weak pleochroism and evidences of having been strained are generally seen, while resorption, with the production of magnetite, is only a rare feature. Hornblende is not a constant constituent, but is always fresh and ragged in outline. The ilmenite is quite a common mineral in the dacites, while magnetite only occurs rarely. The former shows typical alteration to leucoxene, and haematite is invariably found around the margins of the magnetite units. In two of the rocks tiny zircons have been found, and a very little apatite occurs in the majority of the dacites.

The groundmasses of the rocks vary considerably. Sometimes the texture is quite even and entirely cryptocrystalline, consisting most probably of felspar and quartz. At other times there is a variation in the nature of the groundmass from place to place. Thus there may be spherulitic patches and cryptocrystalline areas as well as some residual glass. No entirely glassy groundmasses have been found, although some rocks possessed a considerable amount of vitreous material. Devitrification has occurred in some specimens, especially those containing a pumiceous groundmass. In these cases the cuspate bodies left after the collapse of pumice bubbles have been changed to felspar and then kaolinized.

Examination of *Specimen 5* and certain slides kindly lent by Mr. Sussmilch, all from the little quarry at the foot of Mt. Johnstone, shows that one can at times obtain dacites free from enclosures and at other times it is difficult to do this. The rocks all have a typically felsitic appearance and show considerable amounts of phenocrystic biotite and quartz as well as plagioclase. The plagioclase varies from andesine, $Ab_{11}An_9$, to labradorite, Ab_2An_3, and shows a tabular prismatic habit. There is a little albitization in the case of one rock. The biotite is bent and considerably altered while the quartz shows corrosion and inclusions of the groundmass. The groundmass is always pumiceous and in

some rocks extensive silicification has occurred while devitrification is evidenced in certain cases. Haematite, which is the result of infiltration, is often present, causing a pink colour to be imparted to the rocks. In all cases the rocks are dacites, except in one case where there is a tendency to become a rhyolite.

The rock inclusions in the dacites of this locality comprise obsidian, rhyolite and soda felsite. These are not cognate with the parent rock. In the groundmass of some of the dacites, however, there are present spherulites, which occur in separate little masses surrounded by a border of finely divided silica. These composite inclusions do appear to be more of the nature of cognate inclusions.

Specimens 171 and *495* are from Mt. Gilmore and show a large number of inclusions. In these rocks the felspar becomes as acid as basic oligoclase.

Specimen 415 from the southern part of the Glenoak section is distinctive on account of its blotchy appearance. This, under the microscope, is seen to be due to the prevalence of haematite in certain parts of the groundmass. This rock also evidences a little albitization of the plagioclase.

Chemical composition: A partial analysis, by the writer, of a representative of the dacitic rocks, described above, and occurring at the little quarry near the foot of Mt. Johnstone is as follows:

SiO_2	..	..	67.76
Al_2O_3	..	..	12.89
CaO	..	..	1.16
Na_2O	..	..	2.32
K_2O	..	..	1.88

The composition of the plagioclase, calculated from the above data is andesine of the formula $Ab_{76}An_{24}$. This rock is low in alkalis and the specimen was free from albitization. The silica percentage is of the same order as the values found in the andesites given above, and a complete analysis would almost certainly find its place in the same class and order of the quantitative classification as that in which the andesites are placed.

Quartz-Keratophyres.

Albitization has been detected in the rocks described under this heading, and it is probable that all the albite which causes the rocks in their present condition to be called keratophyres, came along during the late-magmatic period.

The most important examples of these occur right throughout the area, and constitute the Williams River type. The best exposure of this type is in a quarry on the left bank of the Williams River below Clarencetown.

Megascopical characters: The quartz-keratophyres are very constant in their appearance. When fresh the colour is a dark blue, but fresh specimens are rarely obtained and the prevalent colours of the somewhat weathered outcrops are fawn and light green. Flow structure is visible in the arrangement of the phenocrysts which include quartz, biotite and plagioclase. The abundance of biotite often imparts to the rocks a spangled appearance. The groundmass is dense and dull lustred.

Microscopical characters: The rocks show a uniformity in microscopical features, there being in the case of some flows a slight change to a finer texture in the upper portions. *Specimens 131* and *262* from the Mt. Gilmore district are of the Williams River type, and may be taken as typical of the rocks.

The phenocrysts make up 60% of the rock and are themselves present in the following proportions: felspar 60%, quartz 20%, biotite 13%, hornblende 4%, iron ore 2%, apatite less than 1%. In *No. 131* the felspar is all albite and this slide was used in 1922 when the rock was named a biotite-quartz-keratophyre. A slide of *No. 262*, since examined, shows the presence of some residual more basic felspar in the central portions of some of the albite phenocrysts, so that it is very likely that the whole of the albite is of late-magmatic origin. The habit of the felspar is stout prismatic and the lamellar twinning is imperfectly developed. The (001) cleavage which has never been well developed, is obscured by the later albitization. Along some of the cracks sericitic mica has developed as a result of weathering. Associated with the albite is chlorite, which occurs as patches in the felspar and in the groundmass. The biotite is of a brown variety and shows streaky bleaching. Many pieces have been bent, and along the cleavage cracks are found veinlets of haematite.

The quartz is present in equidimensional sections and shows many pseudo-inclusions of the groundmass. Hornblende is not a very prominent constituent, although its presence is significant. It is of a pale green colour and shows pleochroism of medium intensity. The prismatic cleavage is poorly developed, as also is the twinning which has its plane of composition parallel to (100).

	I.	II.
SiO_2	67.06	67.71
Al_2O_3	15.95	15.24
Fe_2O_3	1.78	1.48
FeO	2.37	1.89
MgO	1.87	.46
CaO	1.98	3.00
Na_2O	4.62	5.87
K_2O	2.01	1.81
H_2O+	.65	1.89
H_2O-	.44	.39
P_2O_5	.28	trace
TiO_2	.40	.47
CO_2	absent	absent
SO_3	absent	—
Cl	trace	—
SrO	absent	—
MnO	.39	—
	99.80	100.21

Specific gravity of I = 2.62 at 16° C.

I. Quartz keratophyre, Williams River, near Clarencetown, N.S.W. Analyst, G. D. Osborne.

II. Quartz keratophyre, Church Hill, Currabubula, N.S.W. Analyst, H. Yates.

The iron ore is mostly decomposed and appears originally to have been of both varieties, magnetite and ilmenite. Apatite with acicular habit and a stray section of zircon are present.

The groundmass contains a fair amount of glassy material, but for the most part is cryptocrystalline. The arrangement of the felspar phenocrysts, especially on account of their stout prismatic habit, is such, when the groundmass is very subordinate, as to give rise to an approach to a coarse orthophyric fabric.

Similar rocks to those just described occur higher up in the stratigraphical succession, examples of such being *Specimen 263* in the Mt. Gilmore section, and *Nos. 367* and *402* occurring near Glenoak.

Chemical composition: Chemical analysis has been made of *Specimen 131* of the quartz-keratophyre from the Williams River Quarry and is tabulated above, and with it is placed an analysis of a quartz-keratophyre from Currabubula. These two rocks have different textures and different modes of occurrence in the field, and it is premature to enquire into the question of whether they can be correlated one with the other, but the chemical data give evidence of a certain amount of general similarity, in that the rocks are both sodic and of about the same acidity.

Toscanites and Dellenites.

The rocks coming under this heading are fairly acidic in nature, but they differ entirely in texture and to some extent in the nature of the phenocrysts, from many of the rhyolites. It has been found that a certain flow will in one place be a toscanite and in another place a dellenite due to a gradual variation; but cases of a unit maintaining its toscanitic or dellenitic nature throughout the whole of its occurrence have been seen.

The two most important sets of rocks in this group are those known respectively as the Paterson and Mt. Gilmore types of toscanite and dellenite. Microscopically the two types are somewhat similar, but there are certain differences and it will be well to describe each type separately.

Mt. Gilmore Type.

Megascopical characters: The general body colour of the rock is a brown, the two varieties of felspar, plagioclase and orthoclase, being quite conspicuous, as also is quartz, while subordinate ferromagnesian individuals occur at times, all set in a dense lithoidal groundmass. The texture is so coarse at times and the porphyritic constituents so dominant that one might easily mistake the rocks for specimens of granite-porphyry.

Microscopical characters: The minerals present in *Specimen 261* from Mt. Gilmore comprise quartz, orthoclase, plagioclase, biotite, magnetite and apatite. The plagioclase is of the composition Ab_7An_3. The habit is tabular and the grainsize goes up to a maximum of .6 mm. in diameter. Decomposition is slight, with the development of kaolin, but albitization seems to be absent. The orthoclase is strongly kaolinized and the (001) cleavage is hard to discern. The individuals of quartz are large and equidimensional, showing a lot of corrosion and cracking. Biotite is almost completely resorbed with the production of strings of magnetite. Where unaltered, the mineral is of a pale green colour and feebly pleochroic. The magnetite is allotriomorphic and unaltered. Tiny crystals of apatite are seen as inclusions in the felspar and in the groundmass. The examination of the latter is difficult because kaolin and haematite have effected quite a lot of replacement. There is undoubtedly a little glassy residuum

present, and the main part of the groundmass is cryptocrystalline. Spherulitic structures are absent. This rock is a biotite-dellenite. Elsewhere on Mt. Gilmore the unit becomes a toscanite on account of the plagioclase becoming $Ab_{11}An_9$ in composition and the orthoclase less abundant.

Specimen 391 from the Glenoak extension of the Mt. Gilmore type is a dellenite, in which the quartz is of smaller grainsize than is usual in these rocks, and possesses little in the way of corrosion effects. At Martin's Creek the horizon of the Mt. Gilmore flow is occupied by a toscanite which varies somewhat abruptly along the strike, becoming a dacite. The toscanite consists of basic andesine dominating over orthoclase and quartz, together with biotite and magnetite, all set in a cryptocrystalline groundmass, which has a little glassy base and shows kaolinization.

Paterson Type.

Megascopical characters: The rocks coming under this heading form a very distinctive unit which occurs throughout the whole of the area in a constant stratigraphical position. Since writing in 1922 the writer has not seen much to decide definitely the question of whether the occurrence of these rocks is as a composite sill or as a series of flows, but the microscopical evidence seems to strengthen the tentative view taken then that the latter case was the more likely. Thus, in some rocks, there appears to be a certain amount of tuffaceous material and some pumiceous structures.

In hand specimen the rocks are of a general grey colour where exposed to the atmosphere, but, when broken open, the colour of the comparatively fresh rock varies from brown to grey and blue. Phenocrysts of quartz, orthoclase, plagioclase and biotite are visible as in Specimens 69 and 71 from Hungry Hill, Paterson. At other times felspar is well shown, with quartz quite inconspicuous. The groundmass is always of felsitic appearance.

Microscopical characters: The minerals present comprise plagioclase, quartz, orthoclase, biotite, hornblende, magnetite and apatite. The quartz is generally present in large equidimensional crystals showing corrosion and inclusions of the groundmass. Orthoclase is sometimes fairly plentiful, at other times it becomes quite subordinate and the rock tends to become a dacite. The orthoclase is kaolinized and shows incipient albitization. Plagioclase exhibits a greater susceptibility to be replaced by albite, and along with the albitization is found the presence of chlorite replacing certain portions of the lime-soda felspar. The composition of the plagioclase varies from basic oligoclase to basic andesine. Biotite occurs in strips showing resorption, bending, bleaching and partial alteration to chlorite. The hornblende is quite fresh, although not at all abundant, and it is not of universal occurrence throughout the specimens. Its presence, however, is significant. Magnetite shows peripheral alteration to haematite, while apatite, which is only occasionally seen, is of acicular habit.

The groundmass is very dense and of a dark brown colour. The grainsize is cryptocrystalline in nature for the most part, although there are some patches of a glassy base. In two rocks from the south-west of Mt. Johnstone there are some pumiceous areas in the groundmass which have been devitrified, and this evidence points to these rocks having been extrusive.

Specimen 6, from the top of Mt. Johnstone, shows the presence of a little green hornblende as well as the other constant constituents. The plagioclase is of the composition Ab_3An_2 and the rock is a dellenite.

Specimen 7, from the railway cutting near Paterson Station, shows less phenocrystic quartz than is usual, and there is more albitization. The felspar is acid andesine and the rock a dellenite.

Specimen 70, from Hungry Hill, Paterson, is sandwiched in between two toscanites, *Nos. 69* and *71*. It is more felspathic in appearance than the type rocks, and the rock is almost an andesine-dacite allied to toscanite.

	I.	II.	III.	IV.	V.
SiO_2	73.04	72.98	74.60	72.79	68.36
Al_2O_3	13.86	12.58	13.41	13.77	13.24
Fe_2O_3	1.60	.28	1.28	1.69	1.29
FeO	.45	1.66	.30	n.d.	3.39
MgO	.48	.49	.26	.28	1.15
CaO	1.44	2.81	1.08	1.24	2.51
Na_2O	3.40	4.80	3.38	3.39	2.05
K_2O	4.39	2.99	4.50	4.38	5.34
H_2O+	.79	.79	.85	2.41	2.63
H_2O-	.25	.43	—	—	—
CO_2	absent	absent	—	—	—
TiO_2	.22	.40	.16	—	—
ZrO_2	absent	—	—	—	—
P_2O_5	.04	.08	.03	—	—
V_2O_5	absent	—	—	—	—
SO_3	absent	—	—	—	—
Cl	trace	—	—	—	—
S (FeS_2)	absent	—	—	—	—
F	—	—	—	—	—
Ni, Co. O	absent	—	—	—	—
CuO	absent	—	—	—	—
MnO	.07	.03	.06	—	.27
BaO	.04	—	.11	—	—
SrO	absent	—	absent	—	—
*Li_2O	present	—	trace	—	—
TOTAL	100.07	100.32	100.02	99.95	100.23
Specific Gravity	2.642	2.591	—	2.416	—

I. Dellenite, Mt. Gilmore, N.S.W. Analyst, W. A. Greig.
II. Dellenite, Paterson, N.S.W. Analyst, G. D. Osborne.
III. Rhyolite, California. Analyst, H. F. Hillebrand (Washington, 1917, p. 184).
IV. Obsidian, Hungary. Analyst, A. Logorio (Washington, 1917, p. 203).
V. Dellenite, Dellen, Sweden. Analyst, H. Santesson (Washington, 1917, p. 165).
* Spectroscopic.

Specimen 489, from the Porphyry Estate, Seaham, is a handsome blue rock with phenocrysts of quartz, orthoclase and plagioclase, and under the microscope is seen to be a toscanite. *Specimen 493*, from just south of Felspar Creek, is of interest in containing a little hornblende, and a slightly pumiceous groundmass. These features give it a great similarity to the rock from near Mt. Johnstone.

It is necessary to mention here that, while throughout the area one finds these toscanite and dellenite lavas comprising a group which is isolated from the main Volcanic Stage, still, just near Seaham, in two places, at Felspar Creek and Porphyry Point, respectively, small flows of rhyolite are to be found associated with the other rocks. In the Volcanic Stage, apart from the Mt. Gilmore toscanite-dellenite suite, there are two examples of tuffaceous dellenites in which there are some fragments of felsite and soda rhyolite. Autobrecciation, induced during the solidification of the rocks, is a rare feature, occurring in one instance only.

Chemical composition: An analysis of the Mt. Gilmore type of dellenite, which was kindly made for the author by Mr. W. A. Greig, is given above, together with one of the Paterson type of dellenite, *Specimen 7*, described above, which was carried out by the writer. In addition three analyses of similar rocks are tabulated.

As pointed out in the brief description above, *Specimen 7* shows albitization, the unaltered plagioclase being acid andesine. Calculated from the analysis, the lime-soda felspar is Ab_4An_1, so that the chemical evidence confirms the data derived from microscopical examination. In the case of the Mt. Gilmore rock it will be noted that the soda dominates over the lime, and this causes the calculated composition of the plagioclase to be about Ab_4An_1, practically the same as that determined for the Paterson rock. In both of these rocks there is an appreciable amount of potash, and this feature emphasizes the close relation these rocks have with the sodipotassic rhyolites. On account of the value for soda in the Paterson rock exceeding that of potash, the sub-rang to which it belongs is Lassenose, while the Mt. Gilmore rock fits in the sub-rang Toscanose.

Comparing the first four of the analyses tabulated, it will be seen that the two Kuttung rocks are quite similar in some respects, while the other two rocks, from California and Hungary respectively, show striking similarities to the Mt. Gilmore rock, especially as regards the values for the alkalis. The analysis, No. V, of the rock which was described originally as a hypersthene-andesite and later called a dellenite by Brögger, differs from the analyses of the Kuttung rocks particularly in having higher potash and lower silica, and indeed it is clear that the two Kuttung dellenites are very close to becoming sodi-potassic rhyolites.

Rhyolites.

The rhyolites are very abundant, especially in the Volcanic Stage, and present a variety as regards both chemical composition and texture. On account of the fact that many of these rocks are not strongly porphyritic, it is difficult, in the absence of many analyses, to classify them properly. It seems best, however, to consider them in two main sections, viz., those which contain soda felspar in abundance with the absence of visible orthoclase, and those which are sodi-potassic and in some cases strongly potassic.

Rhyolites characterized by Albite.

These varieties are quite distinct from alkaline lavas whose richness in soda is reflected in the composition of the ferro-magnesian minerals as well

as the felspars, that is to say, the comendite-pantellerite suite. The sodic character of the rocks under consideration is due to the presence of albite, which might reasonably be regarded as of late-magmatic origin.

Megascopical characters: The rocks are light-coloured, and in the case of one important flow, almost emerald green. In the porphyritic varieties the constituents visible are dominant felspar, some quartz and often a little biotite. Frequently, however, there are practically no phenocrysts which can be determined megascopically. The texture of the groundmasses is always felsitic

Microscopical characters: The minerals present are quartz, plagioclase, biotite, magnetite, apatite, and rarely hornblende. Quartz may be quite abundant, while at times it is almost missing from the phenocrysts and occurs in the groundmass. It is generally corroded strongly and shows inclusions of the groundmass. The plagioclase is almost always albite, but in one slide some oligoclase was seen. In this case it was being replaced by albite and, indeed, it is probable that much of the phenocrystic albite in the rhyolites is not of primary crystallization, as it exhibits many of the features of the albite in albitized rocks. The felspar is well formed in most cases and possesses a stout prismatic habit. Biotite is present in variable amount, absent in certain rocks, and it is generally strongly resorbed. The pleochroism is always weak. Hornblende was not observed to be a regular constituent, but its presence was detected in a rock from near the top of Mt. Gilmore. The iron ore is mostly ilmenite, but both ilmenite and magnetite occur, the latter being slightly haematitized. Apatite is found in minute quantities in the majority of the rocks.

The textures exhibited by these sodic rocks are interesting. Cryptocrystalline groundmasses are the rule and these may be so fine that little can be done in the way of resolving them. Where slightly coarser, one can detect the presence of quartz and acid plagioclase. Spherulitic structures are not common, being generally seen in those rocks which show the presence of secondary quartz. The presence of much pumiceous material, considerably altered, is however a distinctive feature. Thus there may be patches of material which consists of remnants of bubbles which have been re-welded, giving the bogen-structur of Mügge (1893). Secondary silicification has in most cases filled the interstices between some of the disrupted bubbles, while devitrification, followed by kaolinization, has brought about a selective replacement of the material composing the pumice remnants. Flow structure is to be found in the rocks which are not pumiceous and sometimes spherulites are found in the lines of flow, apparently having developed after the congealing of the material exhibiting the flow lines.

The most important occurrence of the soda rhyolites is to the west of Martin's Creek near the road at the foot of Mt. Johnstone. *Specimen 258*, from here, is a green rock with an even fracture, and is studded with tabular idiomorphic white felspars. Under the microscope some phenocrysts of corroded quartz are seen, but the felspar is much more abundant, having a spongy appearance suggestive of having developed by deposition during replacement. The grainsize of the felspar is fairly even, and averages about .6 mm. The groundmass is pumiceous and contains some tiny fragments of quartz and rock material. There has been some devitrification and kaolinization. The rock is best called a tuffaceous soda rhyolite. It is almost identical with some specimens from a Kuttung flow at Currabubula, the petrographical features of which have been given by W. R. Browne (1920, p. 408).

While the soda rhyolites are being considered it can be pointed out that there are some flow breccias, e.g., *Specimen 375*, occurring in the Langlands section and elsewhere, which are very sodic and present structures which have developed as a result of autobrecciation during the cooling of an acidic alkaline magma.

Rhyolites in which Orthoclase is an Important Constituent.

These varieties are of more frequent occurrence than the sodic rocks. Using the criterion of the nature of the phenocrysts one can distinguish between sodi-potassic and those which are dominantly potassic, but it is to be remembered that in all cases it is likely that both the soda and potash molecules exist in the material of the groundmass so that the distinction is one of expediency only, and to be used in the absence of analyses.

Megascopical characters: The rocks vary a great deal as regards colour, being often of a dark brown and other times light-coloured. The fracture is quite irregular in those containing large phenocrysts and even in the felsitic types. Quartz is conspicuous in certain specimens and almost absent from others, while the two varieties of felspar are generally distinguishable in hand specimen.

Microscopical characters: Under the microscope the following minerals are present: quartz, orthoclase, plagioclase, biotite, ilmenite, apatite and magnetite. The quartz is always corroded and sometimes considerably cracked, though there are no strain shadows under crossed nicols. The orthoclase may be very dominant in those rocks which are taken as being strongly potassic, while it equals, roughly, the amount of plagioclase in the sodi-potassic varieties. The potash felspar is tabular in habit, is always kaolinized, and invariably shows the (001) cleavage. A little albitization is to be seen in several instances. The plagioclase is generally idiomorphic, and of a tabular prismatic habit. The composition varies from albite to medium oligoclase. Biotite shows a slender habit and generally is strongly resorbed. Ilmenite, indicated by a titaniferous decomposition product, is of more frequent occurrence than magnetite, and apatite is fairly constant in minute prisms.

The groundmass of the rocks is mostly cryptocrystalline and residual glass is not a constant feature, although there is some in certain rocks. Flow structure occurs in one or two cases, but it is the presence of pumiceous patches which forms the commonest feature. There has always been devitrification of this pumiceous glass and sometimes secondary silica has entered and affected these pumiceous areas.

There are many of the sodi-potassic rhyolites in the Mt. Gilmore section as, for example, *Specimens 354, 168, 198, 200* and *497*. Of these *168* is distinctive on account of its reddish colour, and amygdaloidal appearance. The colour is due to the selective replacement, by haematite, of a pumiceous groundmass.

Specimen 497 is of some interest in being the matrix of a volcanic conglomerate at the top of the Mt. Gilmore section. It possesses abundant phenocrysts of quartz with subordinate orthoclase and biotite set in a cryptocrystalline groundmass. Associated with the toscanite of the Paterson type, there occur at Porphyry Point and Felspar Creek, Seaham, varieties of potash rhyolite, e.g., *Specimen 486*, which conform to the general description given above.

Felsites.

In addition to the rocks already described there are quite a number which are non-porphyritic and of a typical felsitic appearance. They are generally light in colour, although some dark brown types are known. Under the microscope one is unable to assign any definite identity to these rocks since phenocrysts are extremely rare and when present are generally of quartz or, if of felspar, are too small or too altered to admit of accurate determination. The groundmass in these rocks, which in places constitutes almost 95% of the whole, may be cryptocrystalline as in the case of *Specimen 374*, from Oakendale, or it may be an altered pumice as in *Specimen 17*, from near the Gostwyck Bridge, Paterson. In this rock the attenuated bubbles have been replaced by kaolin and filled with secondary silica.

In the case of a group of felsitic rocks occurring to the east of the Railway on the southern side of the valley of Martin's Creek (*Specimens 25* and *26*), the groundmass contains many spherulites and axiolites as already described (see above).

In connection with the felsites one can point out that although the phenocrystic felspar was very scarce and always somewhat decomposed, measurements that were made upon the extinction angles suggested that in all cases the felspars were strongly sodic, although the determination was never definite.

Tuffs and Certain Detrital Rocks.

Tuffs.

A salient feature of the Kuttung Series is the abundance of tuff throughout. Much of this tuffaceous material is mixed with detrital sediment and it is impossible to arrive at the composition of the material of truly igneous origin in these cases. There are, however, some tuffs which appear to be of primary deposition and therefore of importance almost equal to that of many flows. These tuffs do not vary much in hand specimen, being generally of a rusty red colour, due to the presence of haematite. At other times the tuffs are greenish, due to the presence of a silicate of iron. The grainsize is generally even and medium, cases of coarse breccia and agglomerate being relatively rare.

Microscopical characters: Microscopically there are seen to be certain differences in the various specimens and the leading types will be considered in turn.

Specimen 147 is from the Mt. Gilmore section and contains fragments of acidic rocks, some of which are felsitic and some of the nature of keratophyres. Albite occurs along with quartz. Some patches of secondary silica are seen and haematite is the cementing material. It is interesting to notice again the prevalence of sodic constituents.

Specimen 10, from the little quarry on the Paterson-Dungog road near Mt. Johnstone, contains fragments of quartz and andesine together with a lot of pumice cemented by a greenish matrix. The pumice has been replaced in part by haematite and shows up well in contrast to the rest of the rock. Secondary silica occurs in patches and there are some vitrophyric rock inclusions.

Specimen 294 which is dark in colour is from the Tillimby paddock, Paterson. It is very finely textured and consists of quartz and indeterminate felspar set in a dark brown matrix. High magnification shows this to consist of tiny pieces of siliceous rock, haematite and chloritic (?) material.

Specimen 298, from about three-quarters of a mile south of Martin's Creek Station and east of the Railway Line, is of interest in that there is a considerable amount of biotite present.

Specimens 373, 381, 383 and *449* are tuffs occurring in the Langlands section and are all of the same general facies, being siliceous, the fragments comprising abundant quartz, acidic rocks (many of which are quite glassy), spherulites, and chips of acid plagioclase.

It will thus be noticed that nearly all the tuffs have constituents which give the rocks alkaline affinities and that in some cases biotite is an important constituent.

Tuffaceous Rocks in the Main Glacial Beds.

The lithology and petrography of the Main Glacial Beds have already been written (Osborne, 1925) and it has been pointed out there that many rocks which would be taken at first sight to be tuffs or breccias are, in part at least, of glacial origin. As a matter of fact there are only local masses of true tuff and breccia, but extensive deposits of tuffaceous sandstones and coarser rocks occur.

With regard to the composition of the few true tuffs, microscopical examination has shown the fairly constant features of a siliceous character and a content of acid plagioclase.

Basal Stage Conglomerates.

Conglomerates form such an important part of the Basal Stage in the vicinity of Wallarobba, Mt. Douglas and Clarencetown, and it is desirable that a petrological description of these be given.

The pebbles in the conglomerates average about 4 inches in diameter, while some are about one foot in diameter. The nature of these old gravels has not been determined in any detail, but the pebbles occur in the following general order of decreasing abundance: quartzites, aplites, cherts, porphyries, felsitic rocks and granitic types. There is an almost entire absence of rocks belonging to the diorite-andesite suite. The nature of the matrix of the conglomerates no doubt varies from place to place. Some samples show, in hand specimen, the presence of fairly fresh chips of felspar along with quartz and tiny rock fragments. A fairly representative sample is *Specimen 152* from Clarencetown, near the Williams River Bridge. Megascopically it is of a dark grey colour, the constituents being of a fine grainsize cemented by argillaceous material.

Microscopically, it is seen to be composed of fragments of siliceous rocks, quartz, and plagioclase, with patches of chlorite and haematite, the cement being kaolinic. Many of the rock pieces are devitrified obsidians possessing spherulites. Other rock types are felsitic and may always have been lithoidal. There is evidence that the fragments have been somewhat rounded by transport.

Petrography of Certain Post-Carboniferous Rocks.

As pointed out in another paper, there occur in the area under discussion remnants of widespread flows of Cainozoic basalt and several dykes of basic material. The material of the dykes is in all cases too much weathered to permit microscopical examination, with one exception, this being the dyke on Mr. A. J. C. Vogele's property at Mt. Douglas.

Specimen 82, from the margin of the dyke, is of finer grainsize than *Specimen 106* which is from the central portion of the mass. Both are somewhat porphyritic in plagioclase and show a typical doleritic appearance.

Microscopical characters: *Specimen 82* is seen to be a good deal decomposed. There are present plagioclase, augite, magnetite, biotite, apatite and a little free quartz. The plagioclase occurs as phenocrysts at times, but the bulk of it belongs to the second generation, having a prismatic habit. It is very much saussuritized and its composition is almost indeterminate, although there is no doubt of it being calcic. Augite is grey and ophitic relations exist between it and felspar. There is very little biotite which, like the magnetite, is fresh. Chlorite and haematite are seen to be filling cracks rather than representing replacement patches due to decomposition. In addition there is a considerable quantity of a secondary greenish silicate. The quartz is interstitial and undoubtedly was the last mineral to crystallize.

Specimen 106 is coarser in grainsize and there is a fair amount of phenocrystic plagioclase which possesses a tabular habit and an average grainsize of 2 mm. The composition of the phenocrysts is about Ab_2An_3, while that of the felspar in the groundmass is slightly more acid. The latter is prismatic in habit and is associated with quartz, augite, titaniferous iron ore, biotite, quartz and apatite, the mass showing ophitic fabric. Chlorite is the chief decomposition product.

Both the above rocks may have the name quartz-bearing gabbro porphyrite or porphyritic dolerite.

Specimen 85 is from the basalt on Mt. Douglas. In hand specimen it has the normal basaltic appearance, and under the microscope is seen to be an olivine-basalt. The olivine phenocrysts are completely pseudomorphed by the material which is generally described as iddingsite, and limonitic stains which have originated from the alteration of the olivine show also that this mineral was originally distinctly ferriferous.

In the groundmass, which is subophitic in texture, there are laths of basic plagioclase, considerable iron ore, augite and apatite, all remarkably fresh in contrast with the olivine. A significant feature in connection with the order of consolidation is that the bulk of the iron ore crystallized in ragged masses after the felspar.

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EXPLANATION OF PLATE XXIII.

Fig. 1.—Example of albitization of a phenocryst of andesine in a rhyolite from Mt. Gilmore. The remnants of andesine are white and stand out in contrast with the rest of the grain which is now albite. Ordinary light. Magnification, 28 diameters.

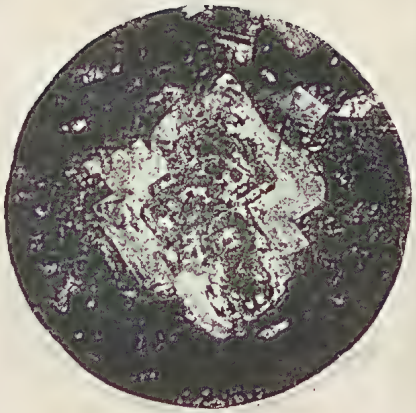
Fig. 2.—Composite zoned crystal of plagioclase in the Martin's Creek andesite showing selective replacement by albite and chlorite. The latter has replaced some of the central zones, while the former is found towards the periphery, and is separated from the chlorite by a zone of unaltered andesine (white). Crossed nicols. Magnification, 12 diameters.

Fig. 3.—Williams River type of quartz-keratophyre. Clear grains of quartz and subidiomorphic grains of spongy albite are set in a dense groundmass. Polarized light. Magnification, 12 diameters.

Fig. 4.—Lithoidal phase of pyroxene-andesite showing the presence of augite (oval grain near centre) and prismatic hypersthene. Polarized Light. Magnification, 12 diameters.

Fig. 5.—Glassy variety of transitional type of andesite. Portion of a resorbed phenocryst of hornblende is to be seen towards the top, while augite and hypersthene are in association as indicated, and small pieces of biotite occur scattered near the centre. Ordinary light. Magnification, 14 diameters.

1



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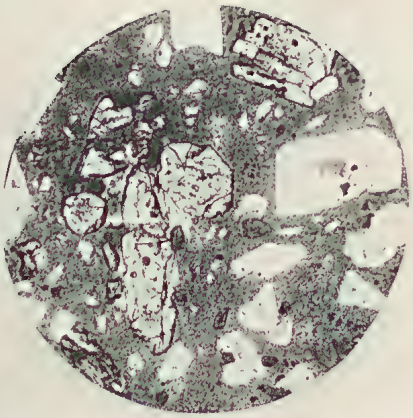

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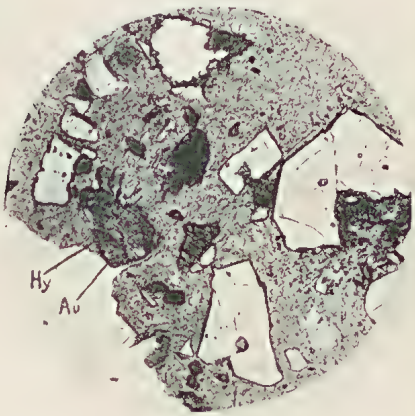


5

AUSTRALIAN MYDAIDAE (DIPTERA).

By G. H. Hardy, Walter and Eliza Hall Fellow in Economic Biology, University of Queensland, Brisbane.

(Two Text-figures.)

[Read 29th April, 1925.]

This paper, revising the described Mydaidae of Australia, was prepared several years ago and, at the time, no less than five species were found to be new, but all the specimens available were old and dilapidated in condition. No further specimens of these, or of any other undescribed Mydaids, appear to have been collected in recent years, and this paper, therefore, does not include new forms. No less than four Australian Entomologists have been seeking knowledge of the family, either for purposes of publication or of identification of material in collections, and so, to supply the growing demand for some knowledge concerning these handsome flies, it is considered advisable to issue the paper in its present form, rather than to await the accumulation of sufficient material for description of specific details, as was originally intended.

The Mydaidae have been revised twice, by Westwood in 1841, and by Gerstaecker in 1868, and both these authors dealt with the species of the World. Westwood's papers are enhanced in value by the excellent coloured figures, whilst Gerstaecker's work marks a big advance in the taxonomy of the family. In the present revision, various names have been placed as synonyms, one being the generic name *Triclonus*, the two specific names of which are now associated with the genus *Diochlistus* for the first time.

Family MYDAIDAE.

This family is recognizable by the complex venation of the wing described below. It contains more or less large elongate flies that have the antennae, usually long, containing five joints, of which the second is small, the third usually the longest and the fifth much wider than the others, inflated on live, but compressed on dried, specimens.

Wings.—The costal and subcostal veins end before the apex of the wing; the mediastinal vein between them reaches beyond half the length of the costa; the radial vein runs into the subcostal considerably before the wing margin. The upper branch of the cubital vein runs into the subcostal, and the lower branch may run to the wing margin, to the subcostal vein, or into the upper branch. In the latter case, the second submarginal cell becomes entirely enclosed by the cubital fork. The first postical vein may be present or absent; it is suggested, in the latter case, that the first postical may be concurrent with the second as one undescribed species retains the two veins, still separated at the base, enclosing a triangular area. The second postical vein runs to about the apex of the wing.

The third and fourth posticals unite before reaching the wing margin, thus closing the fourth posterior cell. The fifth postical runs to the wing margin and joins the anal vein before reaching there.

Distribution.—The family is not known from Tasmania and, judging from the collections examined, there appears to be one species limited in distribution to Queensland, whilst another extends into that State. The majority of the species occur from New South Wales to Western Australia. The correctness of some of the localities given with original descriptions is doubtful, and it is significant to note that Westwood gives "Adelaidam, Australias occidentalis," apparently confusing Adelaide with Western Australia.

Diochlistus gracilis Macquart is only known by recent specimens collected in Eastern Australia, and yet, under a synonym, Westwood gives it as from Western Australia. Under the same species, Schiner adds "New Zealand," an undoubted error which this author also makes under some of his other references to Australian Diptera.

Notes.—There are nine apparently valid species and two genera described from Australia, and of these, eight are definitely distinct; the other species is not represented in the Australian collections examined. Five undescribed Mydaids are very different in appearance from those already described, but they belong to the same two genera. The species are liable to vary in size, shape, and colour, and there are too few structural characters yet found to allow a reliable key to the species to be formed. To minimize the search necessary for the determination of species, a search that requires access to certain works that are rarely represented in the various scientific libraries, the leading colour characteristics of each species are given here; although this scheme may help considerably in any attempt to identify material, reference to the original descriptions and figures needs to be made, as specimens of unusual colours and markings are otherwise liable to be misidentified.

Key to the Genera of the Mydaidae.

First postical vein present, not amalgamated with the second; there are three cells (marked 1, 2 and 3 in figure) between the cell enclosed by the branches of the cubital vein and the hind border of the wing ..... *Diochlistus.*

First postical vein completely coincident (or mostly so) with the second; there are therefore only two cells (marked 1 and 2 in the figure) between the cell enclosed by the branches of the cubital vein and the hind border of the wing ..... *Miltinus.*

Genus Diochlistus Gerstaecker.

Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 73.—*Triclonus* Gerstaecker, ibid., 75. Type, *D. mitis* Gerstaecker, from Swan River, W. Australia.

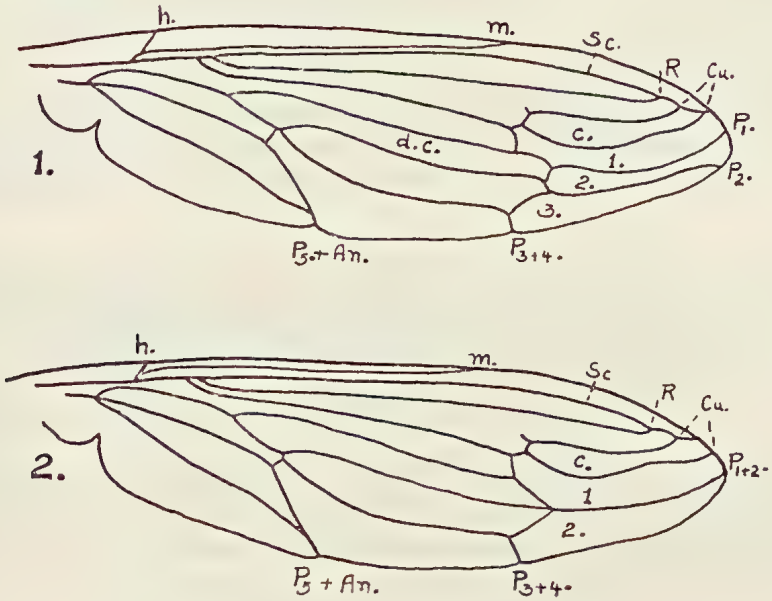
Synonymy.—The differences between the genera *Diochlistus* and *Triclonus*, as given by Gerstaecker, include the structure of the face; the area at the sides of the oral opening are produced and stand out from the eyes in the latter genus, whilst they lie level with, or recede from, the eyes in the former, but this cannot be accepted as of generic value as gradations are found. A second character is the position in which the proboscis is held, namely, horizontally in *Diochlistus* and vertically in *Triclonus;* both positions are found to occur on at least one species placed by Gerstaecker in the latter genus. The wing characters also grade between the species placed under these genera. As Gerstaecker has not offered any reliable character for dividing the genus into two, nor are there any apparent, it is advisable to place the second name as a synonym of the first.

DIOCHLISTUS MITIS Gerstaecker.

Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 73, Pl. i, fig. 1; Osten-Sacken, *Berl. Ent. Zeit.* xxxvi, 1891, 313.

A dull species, black or grey in colour.

Hab.—Western Australia (Gerstaecker). South Australia; 4 ♂, 1 ♀, in the Macleay Museum.



Text-figs. 1-2.—Diagram of the wing venation.
1, *Diochlistus*; 2, *Miltinus*.

h., humeral vein; *m.*, mediastinal vein. *Sc.*, subcostal vein; *R.*, radial vein; *Cu.*, cubital vein with two branches; P_1, first postical vein; second and subsequent postical veins denoted by figures P_2, etc.; and when two of these run together they are denoted as P_{3+4}, etc.; *An.*, anal vein; *d.c.*, discal cell; *c.*, second submarginal, also known as the cubital cell, which is enclosed by the two branches of the cubital vein. The figures 1, 2 and 3 are to draw attention to the number of cells between the cubital cell and the posterior border of the wing; the number of these cells constitutes the most readily perceived distinction between the two genera.

DIOCHLISTUS AURIPENNIS Westwood.

Mydas auripennis Westwood, *Lond. Edin. Phil. Mag.* vi, 1835, 281; *Isis* ii, 1838, 84; *Arc. Ent.* i, 1841, 51, Pl. xiv, fig. 1; Walker, *List Dipt. Brit. Mus.* vi, suppl. 2, 1854, 368.—*Triclonus auripennis* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 75.—*Mydas fulvipennis* Macquart, *Dipt. Exot.* suppl. 4, 1849, 58, Pl. iv, fig. 3.

A yellow species with black thorax. It is peculiar in having the two branches of the cubital vein uniting before they reach the subcostal vein, thus completely enclosing the cubital (second submarginal) cell.

Hab.—Queensland: Brisbane, 1920; Jandowie (Darling Downs), 3 ♂, 1 ♀, December, 1920 (R. Illidge).

Diochlistus gracilis Macquart.

Cephalocera gracilis Macquart, *Dipt. Exot.* suppl. 2, 1847, 32, Pl. i, fig. 5; Walker, *List Dipt. Brit. Mus.* vi, suppl. 2, 1854, 376.—*Triclonus gracilis* Kertesz, *Cat. Dipt.* iv, 1909, 34.—*Mydas bispinifer* Westwood, *Trans. Ent. Soc. Lond.* v, 1848, 88, Pl. xiii, fig. 2; Walker, *loc. cit.*, 1854, 370.—*Triclonus bispinifer* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 75; Williston, *Kansas Univ. Quart.* i, 1893, 154, Pl. x, fig. 10.—*Mydas melleipennis* Westwood, *loc. cit.*, 1848, 87, Pl. xiii, fig. 1; Walker, *loc. cit.*, 1854, 369.—*Triclonus melleipennis* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 75.—*Mydas clavata* Macquart, *Dipt. Exot.* suppl. 4, 1849, 59, Pl. iv, fig. 5.—*Harmophana clavata* Thomson, *Eug. Resa*, Dipt., 1869, 463, Pl. ix, fig. 5.—*Mydas gracilis* Jaennicke, *Abhand. Senckenb. Naturf. Gesell.* vi, 1867, 353, Pl. xliii, fig. 12.—*Mydas effracta* Walker, *Trans. Ent. Soc. Lond.*, iv, 1857, 126.—*Triclonus effractus* Gerstaecker, *loc. cit.*, 76.—*Mydas macquarti* Schiner, *Nov. Reise*, Dipt., 1868, 153; Hutton, *New Zealand Dipt.*, 1881, 31.—*Harmophana flavipes* Thomson, *Eug. Resa*, Dipt., 1869, 463.

Synonymy.—For this species, Gerstaecker used the specific name *bispinifer*, as he considered *gracilis* to be preoccupied by *Mydas gracilis* Macquart. Schiner proposed the name *macquarti* to take the place of *clavatus*, as he placed the species under the genus *Mydas* where the latter name had already appeared. *Mydas melleipennis* Westwood, *Mydas effracta* Walker and *Harmophana flavipes* Thomson appear to belong here. The other names were placed as synonyms by Gerstaecker.

Note.—A black species with a pair of yellowish or reddish spots on each of the three or four basal segments of the abdomen. The legs vary in colour.

Hab.—New South Wales: Sydney, December, a series of both sexes. Queensland: Stanthorpe and Tambourine Mountain.

Genus Miltinus Gerstaecker.

Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 88.

Type, *M. cardinalis* Gerstaecker, South Australia.

Miltinus cardinalis Gerstaecker.

Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 90, Pl. i, fig. 5.

A reddish species; the abdomen with black lateral spots on the segments.

Hab.—South Australia. In the Macleay Museum there are thirty-one specimens without further data.

Miltinus bicolor Westwood.

Mydas bicolor Westwood, *Arc. Ent.* i, 1841, 53, Pl. xiv, fig. 2; Walker, *List Dipt. Brit. Mus.* i, 1848, 228; also vi suppl. 2, 1854, 368.—*Miltinus bicolor* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 90. *Miltinus haemorrhous* Gerstaecker, *loc. cit.*, 89.

Synonymy.—The colour characters of *Mydas bicolor* Westwood and of *Miltinus haemorrhous* Gerstaecker are the same. Both are recorded from the same State, and a series before me agrees with both descriptions and with Westwood's figure. Apparently there are no published characters whereby *haemorrhous* can be distinguished from *bicolor*, even should they prove to be distinct, and on this account they are regarded as one species.

Note.—A black species with the legs and the posterior segments of the abdomen red.

Hab.—Western Australia: Perth, December, 1911, 6 ♂, 1 ♀, all of which have been attacked by *Anthrenus*. The species is very common around Perth, where it can be found hovering over bare sandy patches amongst low vegetation.

Miltinus maculipennis Westwood.

Cephalocera maculipennis Westwood, *Arc. Ent.* i, 1841, 55, Pl. xiv, fig. 5; Walker, *List Dipt. Brit. Mus.* vi, suppl. 2, 1854, p. 375.—*Miltinus maculipennis* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 90.

This reddish species with the apex of the abdomen black is rendered very conspicuous by having a large black blotch in the centre of the wing.

Hab.—Western Australia: Cunderdin, 1 ♂, in the Queensland Museum.

Miltinus sordidus Westwood.

Mydas sordidus Westwood, *Trans. Ent. Soc. Lond.* v, 1848, 89, Pl. xiii, fig. 3; Walker, *List Dipt. Brit. Mus.* vi, suppl. 2, 1854, 370.—*Miltinus sordidus* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 90.—*Mydas limpidipennis* Westwood, *l.c.*, 90; Walker, *loc. cit.*, 369.—*Miltinus limbipennis* Gerstaecker, *loc. cit.*, 90.—*Mydas claviger* Walker, *List Dipt. Brit. Mus.* i, 1848, 229; vi, suppl. 2, 1854, 367.—*Miltinus claviger* Gerstaecker, *loc. cit.*, 90.

Synonymy.—The type of *Mydas sordidus* is from Adelaide; Gerstaecker gives Western Australia as a locality. The type of *M. limpidipennis* is from Western Australia, but as Westwood credited Adelaide to the same State (Australiae occidentalis), this recorded habitat cannot be considered satisfactory. Westwood's two names appear to be referable to different forms of the same species. The type of *Mydas claviger* Walker is stated to be near *M. sordidus*, but it will probably prove identical with that species.

Note.—A black species with triangular red lateral spots on the segments of the abdomen.

Hab.—South Australia.

Miltinus stenogaster Westwood.

Mydas stenogaster Westwood, *Arc. Ent.* i, 1841, 53, Pl. xiv, fig. 3; Walker, *List Dipt. Brit. Mus.* i, 1848, 228; vi, suppl. 2, 1854, 368.—*Miltinus stenogaster* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 90.

A black species with a red abdomen.

Hab.—Western Australia.

Miltinus viduatus Westwood.

Mydas viduatus Westwood, *Lond. Edin. Phil. Mag.* iv, 1835, 281; *Isis* ii, 1838, 85; *Arc. Ent.* i, 1841, 52, Pl. xiv, fig. 2; Walker, *List Dipt. Brit. Mus.* i, 1848, 299; and vi, suppl. 2, 1854, 369.—*Miltinus viduatus* Gerstaecker, *Stett. Ent. Zeit*, xxix, 1868, 89.—*Mydas concinnus* Macquart, *Dipt. Exot.* suppl. 1, 1846, 58, Pl. vi, fig. 5; suppl. 3, 1848, 17, Pl. ii, fig. 1; Walker, *List Dipt. Brit. Mus.* vi, suppl. 2, 1854, 369; V.d. Wulp, *Tijd. v. Ent.* xix, 1876, 171.—*Mydas varipes* Macquart, *Dipt. Exot.* suppl. 4, 1849, 58, Pl. iv, fig. 4.—*Miltinus varipes* Gerstaecker, *Stett. Ent. Zeit.* xxix, 1868, 89.—*Mydas signatus* Walker, *Trans. Ent. Soc. Lond.* iv, 1857, 126.

Synonymy.—Gerstaecker included *Mydas concinnus* Macquart and *Mydas signatus* Walker in the synonymy of this species. *Mydas varipes* Macquart also appears to be the same species.

Note.—Normal specimens of this species are entirely black. In the Macleay Museum there is a variety, from South Australia, that has the fourth and subsequent segments of the abdomen red; this variety must not be confused with *M. bicolor*, and it does not conform to the description of *M. haemorrhous* Gerstaecker.

Hab.—New South Wales: Sydney and Blue Mountains. South Australia: two specimens in the Macleay Museum.

AN ECOLOGICAL STUDY OF THE FLORA OF MOUNT WILSON.

Part ii. The Eucalyptus Forests.

By Arthur H. K. Petrie,
Demonstrator in Botany in the University of Sydney.

(Plates xx-xxii; and four Text-figures.)

[Read 29th April, 1925.]

Contents.

1. Introduction.
2. General Physiognomy of Eucalyptus Forest.
3. Classification of Communities.
4. The Associations.
5. The *Eucalyptus-Doryphora* Ecotone.
6. The *Eucalyptus goniocalyx-E. Blaxlandi* Association.
7. The *Eucalyptus piperita-E. haemastoma* var. *micrantha* Association.
8. The Stratum-Societies of the Junction Flora.
9. Summary.

Introduction.

In the first of these Memoirs on the plant-covering of Mount Wilson, a study was made of the vegetation of the basalt soil, which comprises the Malayan Rain-Forest and certain communities on the outskirts dominated by the endemic *Eucalyptus*. In this second Part it is proposed to give a brief account of some of the salient features of the Eucalyptus Forests, which constitute the vegetation of the sandstone plateau, supplementing also the previous observations on the Eucalyptus communities of the basalt. A third publication will deal with the plant communities of the valleys and their distribution, correlating them with those of the plateau.

Eucalyptus Forest, the unique Endemic Flora of this Continent, is perhaps one of the most extensive plant formations in the world, and its ecology is practically an unopened book: little more has, therefore, been attempted in the present paper than to outline the main communities in the small area under consideration; to record some observations on their distribution and inter-relationships; and to hint at a few of the many important problems connected with their adaptations, development, and such other features as are urgently awaiting intensive study.

I have to record my indebtedness to Assistant-Professor McLuckie for his help in the field and advice in the preparation of the paper; to Professor Lawson for the interest he has always shown in the Mount Wilson work, and for suggestions on a number of occasions; to Mr. M. B. Welch, B.Sc., A.I.C., for kind permission to reproduce one of his photographs of Mount Wilson; and to Mr. O. D. Evans for his generous assistance in the identification of a number of the types referred to in this paper.

General Physiognomy of Eucalyptus Forest.

Eucalyptus Forest, the chief expression of the Australian endemic flora, as has been said, is perhaps one of the most extensive plant formations in the world, and occupies the greater part of Australia.

It was stated in Part I that the Australian flora possessed a number of outstanding peculiarities; and, indeed, many of the features of the Eucalyptus Forests are unique. With a few exceptions, the association dominants are species of *Eucalyptus*, and the fact, that there are about three hundred species in Australia, gives some idea of the peculiar complexity of the formation; despite this, however, the physiognomy is characteristically uniform, the components, almost entirely xerophytes, being typically sclerophyllous in life-form. All the species of *Eucalyptus* possess the same xerophytic facies imparted by their gnarled and spreading boughs, and broad crown of drooping isobilateral leaves. The foliage is small in amount for the size of the trees, being chiefly distal, a xerophytic adaptation which is not least among the distinctive physiognomic features of these trees. The bark is also characteristic, being either stringy, rough, often fissured, and dark grey in colour; or else smooth, pale bluish-grey in colour, containing chlorophyll in the phelloderm, and being cast annually. The accompanying plates (Pl. xx-xxii) help to bring out a number of these features.

The trees are seldom close enough for their crowns to meet, and in any case the open nature of their foliage results in little obstruction to the penetration of light to the ground; there is thus considerable scope for the development of shrubs, which are a characteristic feature of most Eucalyptus Forests, and are extremely numerous in species and life-form (see Text-fig. 1), although the majority are markedly xerophytic, sclerophyllous and often coriaceous. The ground between the shrubs is occupied by smaller shrubby plants, grasses and annuals, also highly xerophytic.

Thus, on the whole, Eucalyptus Forest is a very xerophilous type of vegetation; but some associations, adapted to damp or sheltered habitats, as has been seen on the basalt at Mount Wilson, contain more mesophytic types, although it is noteworthy that many of the latter are Malayan rather than endemic in origin.

The contrast between Eucalyptus Forest and the Rain-Forest at Mount Wilson is profound: the former is lowly integrated and a characteristic expression of xerophily; the latter has the high integration characteristic of luxuriant vegetation and is typically mesophilous. This feature of integration is clearly shown by the result of the cutting out of the dominants in the two communities: in the Eucalyptus Forest no great change as a rule ensues, except that the shrubs form a closer community; in the Rain-Forest, on the contrary, there is little doubt but that the majority of the subordinates, which are present only as a result of the powerful reaction of the dominants upon the rest of the community, would disappear entirely; even in the Eucalyptus-Doryphora association great changes have taken place. Thus it is that the interdependence characteristic of the Rain-Forest is distinctly lacking in Eucalyptus Forest: epiphytes are scarce; ombrophytes are absent. Another feature of contrast, so far as Mount Wilson is concerned, is the great floristic richness which often characterises Eucalyptus Forests and increases the possibility of variation; while the Rain-Forest is comparatively poor in number of species at Mount Wilson on account of the severity of the climate.

Classification of Communities.

With those who are carrying out the pioneering investigations in synecology in Australia, lies the responsibility of co-ordinating upon a scientific basis of classification the communities which they are studying; and the fact, that little has so far been done in this direction, added to the great complexity of Eucalyptus Forests, is such as to render their ecological classification a task often beset with difficulty. In this study the concepts of the British workers have been followed as closely as possible, these being based largely on Clements's scheme (Clements, 1916) with the adoption, however, of Tansley's conception of climax communities (Tansley, 1920). The Eucalyptus Forests have been divided into associations, regarding all communities resembling one another in floristic composition as belonging to one association, these being divided into consociations according to the distribution of the dominants. In certain cases the number of consociations in an association will probably be found to be extraordinarily large when all the Eucalyptus Forests have been surveyed, an inevitable consequence with lowly integrated communities and with a genus so versatile as *Eucalyptus*. This is a feature which leads to a certain difficulty in nomenclature: for instance, what is assuredly one association, having consociations of *Eucalyptus piperita* and *E. haemastoma* var. *micrantha* at Mount Wilson, is dominated in other localities on the Blue Mountains by *E. Sieberiana* and other species, while in the Sydney districts consociations of *E. haemastoma* and *E. pilularis* have been observed. In designating such an association, as Clements has pointed out, only two names can be used; yet it is desirable that the two selected should be the dominants most widely distributed and most characteristic of the association. As this information has not yet been obtained in the case in question, the association has been named for the present from the two dominants occurring at Mount Wilson. It must be understood, however, that this term will possibly require alteration later on; indeed, the whole concept of the status of the communities of the Eucalyptus Forests and their nomenclature, given in this paper, must be regarded as more or less tentative, being only a first attempt based upon observations made over a small area.

The low integration of Eucalyptus Forests is likely to be responsible for many problems connected with the definition of status. It is no uncommon occurrence for one society of shrubs to occur in two different associations; and the typical shrub-stratum of a Eucalyptus association may occur where the development of trees is inhibited, with the result that the shrub-community changes from the rank of a stratum-society to that of a definite association. Examples of these phenomena will be discussed in the subsequent pages.

Having divided the Eucalyptus Forest into associations, it is desirable to have a name for Eucalyptus Forest as a whole, and for this the term "formation" seems to suggest itself. Unfortunately this word has had a somewhat chequered career, being used in different senses by different workers: yet this reversion to its use in the sense indicated by Warming (1909) seems perhaps more useful in the present instance than the most recent definition of Tansley (1920); this, however, only time and the work of subsequent investigators of Australian ecology will show.

The Associations.

Following upon the method of classification adopted above, two associations have been recognised for the present in the Eucalyptus Forest at Mount Wilson.

They are:

(1) An association dominated by *Eucalyptus goniocalyx, E. Blaxlandi* and *E. viminalis*, which will be termed for convenience the *Eucalyptus goniocalyx-E. Blaxlandi* association. This includes what was previously called the *Eucalyptus-Alsophila* association and part of the *Eucalyptus-Pteridium* association.

(2) The *Eucalyptus piperita-E. haemastoma* var. *micrantha* association, which clothes the greater part of the sandstone plateau and the dry slopes.

In addition to these is the Eucalyptus-Doryphora association, which is perhaps better regarded as an ecotone.

The Eucalyptus-Doryphora Ecotone.

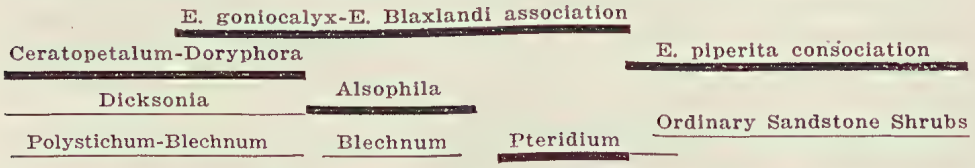
This community has been described already in Part I (p. 485), and represents the ecotone between the *Ceratopetalum-Doryphora* and the *Eucalyptus goniocalyx-E. Blaxlandi* associations. In such places as it forms a thin, fragmentary fringe at the edge of the *Ceratopetalum-Doryphora* association, *Eucalyptus goniocalyx* and *E. Blaxlandi* are co-dominants, while *E. viminalis* is occasionally present; the optimum expression of the association, however, is found on the lower slopes of the mountain, on the first basalt residual reached by the road from Bell (see Map, Part I, Plate lvii). Here *Eucalyptus viminalis* occurs as a dominant in certain areas, while *Eucalyptus oreades* is locally dominant, forming societies in which the other species are only occasional.

The Eucalyptus goniocalyx-E. Blaxlandi Association.

Nomenclature.

What were termed the *Eucalyptus-Alsophila* and *Eucalyptus-Pteridium* associations have been described at some length in Part I. The system of nomenclature adopted therein for these communities, however, was purely a tentative one; for, at the time of writing, the observations on the distribution of the Eucalyptus trees were not verified, and therefore were not adopted as a basis of classification. Meanwhile, a special study has been made of the distribution of *Eucalyptus* at Mount Wilson, and it is now possible to place the nomenclature of these communities upon a more logical foundation.

The co-ordination of the communities of the Junction Flora, however, is found to be by no means simple, as is indicated by the following diagrammatic representation of the manner in which they overlap in the various strata:



It is here seen that the *Alsophila* zone does not delimit an association, since the dominant trees extend into the *Pteridium* zone; and also the *Pteridium* zone extends into the *E. piperita* Forest, an example of the low integration of Eucalyptus communities. These facts have led to the establishment of the following system of nomenclature:

Ceratopetalum-Doryphora association

Eucalyptus-Doryphora ecotone

E. goniocalyx-E. Blaxlandi association
- *Alsophila* stratum-society
- *Pteridium* stratum-society

E. piperita consociation of the *E. piperita-E. haemastoma* var. *micrantha* association
- *Pteridium* stratum-society
- Typical sandstones shrub stratum-society

Distribution and Structure.

The *Alsophila* and *Pteridium* stratum-societies have been discussed to some extent in Part I; it remains, however, in this and a subsequent Part, to record some observations on the distribution of the components of the tree-stratum.

Eucalyptus goniocalyx, *E. Blaxlandi* and *E. viminalis* are seldom if ever co-dominant in one place, more usually forming consociations in which the others are only subordinate; *E. oreades* occurs also as a locally frequent type in this association.

The *E. viminalis* consociation, with *E. Blaxlandi* abundant, was observed only in one place (see Plate xxi, fig. 5), on a southern basalt slope near the road immediately east of the Section line (see map, Part I, Plate lvii); elsewhere the *E. goniocalyx* consociation, with *E. Blaxlandi* (f-a), *E. viminalis* (lo) and *E. oreades* (lf), is more usually found (Plate xx, fig. 1). The *E. Blaxlandi* consociation, with *E. goniocalyx* (o), occurs on the summit of basalt hills which are fully exposed to the west (*e.g.* summit of hill on left of Text-fig. 3, Part I, p. 489); here the *Pteridium* society usually replaces *Alsophila*. Further reference will be made to the distribution of these consociations in Part III.

The tree-fern barrier, and the junction between the *Blechnum* and *Pteridium* societies, are correlated with no difference in the structure and composition of the tree-stratum. At the periphery of the basalt caps the volcanic-soil stratum grows very thin, and finally disappears. It may be supposed that the shallow-rooting Alsophilas cease when the basalt soil is no longer deep enough for them to root in. The *Eucalyptus* trees, however, are not restricted to the basalt in this way, and, indeed, for some distance on to the periphery of the basalt they probably send their roots partly into the underlying sandstone: they appear to be controlled in their distribution by high moisture requirements, which are satisfied not only on the basalt but also on the adjacent sandstone. Thus in one locality the same consociation spreads over the *Alsophila* and *Pteridium* societies up to the junction with the *Eucalyptus piperita* Forest.

The association is plainly suited to a moister or richer soil than the typical dry-sandstone Eucalyptus Forests, being confined to the basalt and the adjacent sandstone which is probably enriched by leaching and percolation from the former, and also to the damp soil of the valleys.

The dominant trees are of great stature, averaging 150 to 200 feet in height, and with a spread often 40 feet in diameter; but they are never near enough to one another to form a closed canopy, a point well illustrated in Part I, Text-fig. 4 (p. 488).

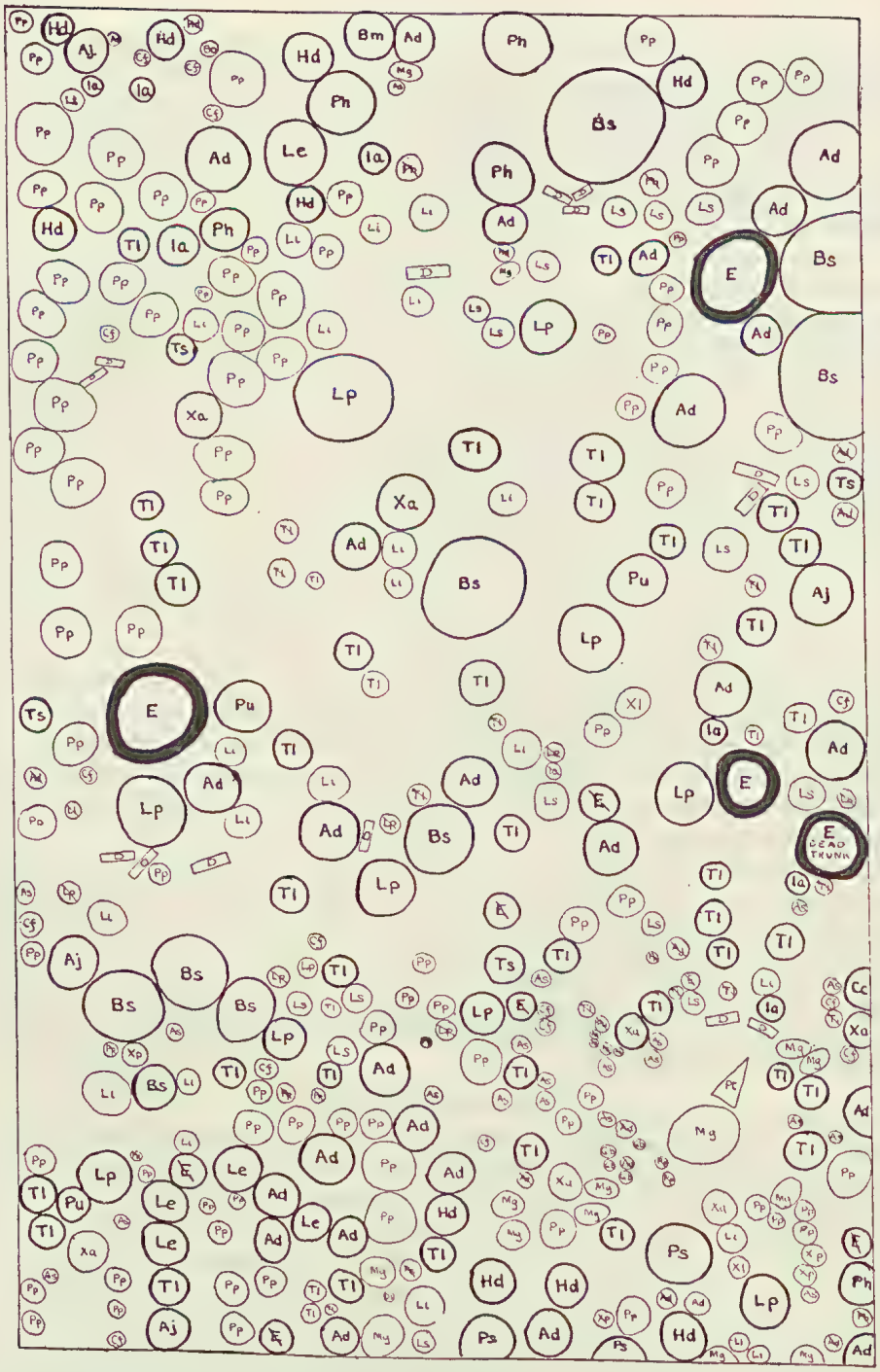
The Stratum-Societies.

Some additional observations have to be recorded upon certain of the stratum-societies of the Junction Flora, but for various reasons it is felt advisable to withhold these until after the discussion of the *Eucalyptus piperita* Forest.

THE EUCALYPTUS PIPERITA-E. HAEMASTOMA VAR. MICRANTHA ASSOCIATION.

STRUCTURE AND PHYSIOGNOMY.

This association is the main expression of Eucalyptus Forest as it occurs on the Hawkesbury Sandstone in New South Wales, and possesses the characteristic structure and physiognomy to which reference has already been made. Although the total number of dominants of the whole association is large, at Mount Wilson there are only two, namely *Eucalyptus piperita* and *E. haemastoma* var. *micrantha*



Text-fig. 1.—Chart of a portion of the *Eucalyptus piperita* consociation, showing the complex composition of the shrub strata. The tall shrubs are indicated with heavy outlines. The structure of the lower strata is seen to be slightly more open beneath the canopy of the trees. (Scale, 1 in. = 6 ft.)

These trees occur in consociations, and attain a height of from fifty to one hundred feet according to the degree of exposure and soil-moisture. *Eucalyptus Sieberiana* and *E. eugenioides* are subordinates.

The shrub-stratum has a more or less open structure and ranges from four to six feet in height (see Plate xxi, fig. 3), although an occasional individual attains the stature of a small tree. The low-shrub stratum is also of open structure, reference to the chart (Text-fig. 1) indicating how much of the ground is bare; it may be supposed, however, that the habitat is covered to the limit of the comparatively meagre supply of water and nutrient materials.

The shrubs are all of the evergreen sclerophyllous type, but otherwise they tend to show unlike reactions to the environmental conditions, although many species belonging to different genera and even different families may have reacted along the same lines and hence may bear close similarities.

There is a general tendency towards reduction in size, the most characteristic feature of xerophily. This is expressed particularly in the chlorophyll-bearing organs, but that the vegetation in question is not an extremely arid type is clearly evinced by the fact that, although the leaves are generally small, in only a few of the species are they minute or even acicular; and, while the majority of the species of *Acacia* bear phyllodes, *A. discolor* has pinnate leaves and yet finds a favourable habitat in this association. Quite another line of reaction is shown in a small number of types with comparatively large leaves, such as *Banksia serrata* and *Persoonia salicina*, which have broad leaves up to six inches in length; in the majority of such types, however, the leaves are isobilateral, as in the case of *Persoonia*.

The structural adaptations of these sandstone xerophytes have not yet been submitted to detailed study, but it is hoped that such an inquiry will form the subject of a later publication.

THE RELATION TO FIRES.

Bush-fires are a fundamental factor controlling the development of Eucalyptus Forests in New South Wales, since their occurrence throughout the summer is so frequent; and the greater part of the Eucalyptus Forest of the Mount Wilson plateau has at some period been burnt, to which charred wood and blackened tree-trunks bear abundant evidence.

These fires pass through the Forest with considerable ease and rapidity, a fact made possible by the low water-content of the plants and the inflammable essential oils present in the leaves of the myrtaceous and rutaceous types. As a

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KEY TO SYMBOLS (Tex-fig. 1).

Tree Stratum.
E, *Eucalyptus piperita.*
Tall-shrub Stratum.
Ad, *Acacia discolor.*
Aj, *Acacia juniperina*
Bm, *Banksia marginata.*
Bs, *Banksia spinulosa.*
Cc, *Choretrum Candollei.*
Hd, *Hakea dactyloides.*
Ia, *Isopogon anemonifolius.*
Le, *Leptomeria acida.*
Lp, *Leptospermum stellatum*

Tall-shrub Stratum (contd.).
Ph, *Pomaderris ledifolia.*
Ps, *Persoonia salicina.*
Pu, *Pultenaea scabra.*
Tl, *Trachymene linearis.*
Ts, *Telopea speciosissima.*
Low-shrub Stratum.
As, *Acacia linifolia* var.
Bo, *Bossiaea scolopendria.*
Cf, *Caustis flexuosa.*
D, *Dianella* sp.
Ds, *Dampiera stricta.*
Gb, *Goodenia bellidifolia.*

Low-shrub Stratum (contd.).
Li, *Lissanthe sapida.*
Ls, *Lomatia silaifolia.*
Mg, *Mirbelia grandiflora.*
Pp, *Phyllota phylicoides.*
Pt, *Pteridium aquilinum.*
Xa, *Xanthorrhoea hastilis.*
Xl, *Xerotes longifolia.*
Xp, *Xanthosia pilosa.*

A line through a symbol indicates a young plant or seedling.

consequence of the latter, the fires frequently run up the Eucalyptus trees and burn off their foliage; but it is evident that the low water-content of the leaves is the chief factor accelerating the fires, since they travel mainly through the shrub-stratum, where the percentage of oil-containing types is not high. Moreover, the essential oils themselves, unless in leaves of low moisture-content, do not make burning possible; for fires have not been observed to have passed through the Rain-Forest, although *Doryphora* contains as much essential oil of an inflammable nature (approximately 1%) as many species of *Eucalyptus* (Penfold, 1921).

The recovery of *Eucalyptus* trees after fire has been referred to in Part I: if the foliage is burnt, it is renewed by the production of adventitious shoots from the stem (see Plate xxi, fig. 4); if the trunk is burned, new shoots arise from the base: indeed it is only occasionally, except at very high altitudes (*e.g.* on the Snowy Mountains), that a tree does not recuperate after fire. Similarly many of the shrubs possess subterranean rootstocks from which they send up new shoots after subaerial destruction by fire.

Thus after pyric denudation it is possible for regeneration to take place without the initiation of a sere: the previous community may reproduce itself without any alteration in structure, every plant reappearing in its previous place. At all events, since the area is a secondary one, and since it is improbable that the habitat factors are changed very much, if succession does take place, the sere is generally short and simple: there is as a rule nothing to prevent the migration and germination of seeds of the types previously existing in the habitat, which usually seize the opportunity of pyric denudation to establish their seedlings.

Such aberrations as appear in the early period of regeneration may be due to differences in readiness of renascence, in aptitude of establishment, or in aggressiveness, of different types. As an example of the first-mentioned factor may be instanced the rapid spread of *Pteridium* before the rootstocks of the shrubs have time to produce their shoots. In the association under discussion, however, on account of the unfavourableness of the habitat, this type is as a rule not sufficiently aggressive to prevent the developing shrubs from subsequently extinguishing it. Along with *Pteridium* in the early stages we have noticed *Dianella* spp., *Xerotes longifolia*, *Lomatia silaifolia*, and *Panax sambucifolius*, which appear to possess the ability of rapid renascence.

Many of the endemic types have also most unique adaptations for recolonisation after fire. In a poor siliceous soil like that produced by the Hawkesbury Sandstone there is keen competition between the different components of the vegetation for the small quantity of available nutriment and moisture. It is, therefore, to be expected that a species will always endeavour to seize any opportunity which may be afforded for gaining an ascendancy over the other members of the community; and it is obvious that, if seeds could be preserved during fire, such an opportunity would be gained, inasmuch as recolonisation would not have to await the comparatively slow process of migration from an unburnt adjacent area. Hence many types, notably most of the Myrtaceae and Proteaceae (especially *Hakea*), have developed an enormous amount of wood in the fruit, with the result that even if that structure is appreciably charred, the seed is uninjured; others, such as *Persoonia*, have succulent fruits, but hard seeds within; while hard seeds are found also in *Actinotus*, *Acacia*, etc. Thus protected from destruction during the fire, it is advantageous for these seeds to be able to germinate immediately afterwards: it is interesting to observe, therefore, that, while on account of their

massive structure these fruits often do not open for a number of years, the heat of a fire causes immediate dehiscence; and many seeds appear also to profit by the fire inasmuch as it chars the testa and so allows penetration of moisture for germination.

These plants thus seem to have adapted themselves to benefit by fires, since they gain an opportunity of establishing seedlings before the regeneration of the previous components of the community; these seedlings are thereby given a start in competition, and can at all events take the place of any individuals which have not survived, and of such species as possess no means of renascence, thus gaining considerably in competition with the latter. In any case it is unlikely that much would be gained by scattering seeds through a more or less mature community growing in an unfavourable habitat, since all available space permitted for plants by the limiting soil-moisture factor would already be occupied. These plants, therefore, seem to find it best to withhold their seeds until a fire occurs; and fruits of *Hakea* sometimes remain on the tree for several years without dehiscing, the seeds still retaining their vitality.

The point to be gathered, then, is that the regeneration of Eucalyptus Forests following pyric denudation is not dependent on the comparatively slow process of migration, but is effected mainly by the renascence of the previous components, and also by aggregation, which is a most distinctive feature of this Australian endemic flora.

Not only is the greater part of Eucalyptus Forest secondary in nature, but many areas are not even mature. The ultimate composition is no doubt established, but some of the shrubs take a number of years to attain their maximum height, since their growth has the slowness characteristic of xerophytes.

The majority of the taller shrubs reach a height of from four to eight feet; but certain of them, notably *Banksia serrata*, *Hakea dactyloides* and *Persoonia salicina*, when given the opportunity, develop into small trees having a height of twelve to twenty feet.

THE EUCALYPTUS PIPERITA CONSOCIATION.

Distribution.

This is the most characteristic community of the sandstone plateau, and forms the greater bulk of the vegetation of the Mount Wilson region (see Plate xx, fig. 2). *Eucalyptus haemastoma* var. *micrantha* grows frequently on the more exposed westerly ridges. *E. Sieberiana* occurs generally throughout the consociation as a subordinate, becoming abundant at the apex of exposed bluffs on the western side, sometimes to the exclusion of *Eucalyptus piperita*, so that it forms a society; such societies are no doubt fragmentary representations of a *Eucalyptus Sieberiana* consociation which occurs on other parts of the Blue Mountains. *Eucalyptus eugenioides* was observed in one small area on a westerly headland.

Floristic Composition.

The following list includes the more typical components of the consociation as it occurs on the sandstone plateau in the immediate neighbourhood of Mount Wilson.

Tree Stratum.			
Eucalyptus piperita Sm.	d	*Eucalyptus haemastoma* Sm. var. *micrantha* DC.	lo-lf
Eucalyptus Sieberiana F.v.M.	f-o*	*Eucalyptus eugenioides* Sieb.	lo

* In these lists, where two symbols are given, the first represents the more typical frequency.

Floristic Composition—continued.

Low-Tree Stratum.	
Banksia serrata L.	o-r
Persoonia salicina Pers.	r-o
Hakea dactyloides Cav.	r
Callicoma serratifolia Andr.	la in gullies
Acacia elata Cunn.	lc in gullies
Tall-Shrub Stratum.	
Trachymene linearis Spreng.	c-o
Persoonia salicina Pers.	f-lc
Leptospermum flavescens Sm.	f-o
Leptospermum stellatum Cav.	f-o
Banksia spinulosa Sm.	f-o
Hakea dactyloides Cav.	f-o
Isopogon anemonifolius R.Br.	f-o
Telopea speciosissima R.Br.	o-f
Dillwynia ericifolia Sm.	o-f
Petrophila pulchella R.Br.	o-f
Acacia discolor Willd.	o-f
Acacia longifolia Willd.	o-la
Pultenaea scabra R.Br.	o-la
Pomaderris ledifolia Cunn.	o-lc
Persoonia mollis R.Br.	o
Persoonia acerosa Sieb.	o
Choretrum Candollei F.v.M.	o
Persoonia ferruginea Sm.	o
Xanthorrhoea hastilis R.Br.	o
Persoonia pinifolia R.Br.	o-r
Banksia marginata Cav.	o-r
Leptomeria acida R.Br.	r-o
Leucopogon lanceolatus R.Br.	r-o
Banksia collina R.Br.	lo
Hakea gibbosa Cav.	lo
Haemodorum planifolium R.Br.	lo
Darwinia taxifolia Cunn.	lo
Leptospermum stellatum Cav. var. *grandiflorum* Benth.	lo
Cassinia denticulata R.Br.	lo
Exocarpus stricta R.Br.	r
Leptospermum scoparium Forst.	r
Oxylobium trilobatum F.v.M.	r
Callistemon lanceolatus DC.	vr
Low-Shrub Stratum.	
Phyllota phylicoides Benth.	a-f
Ionidium filiforme F.v.M.	f
Dianella revoluta R.Br.	f-o
Lissanthe sapida R.Br.	f-o
Tetratheca ericifolia Sm.	o-a
Tetratheca thymifolia Sm.	o-a
Pteridium aquilinum Kuhn.	o-la
Acacia linifolia Willd. var.	o-la
Lomatia silaifolia R.Br.	o-c
Dampiera stricta R.Br.	o-c
Low-Shrub Stratum (contd.).	
Goodenia bellidifolia Sm.	o-f
Mirbelia grandiflora Ait.	o-f
Amperea spartioides Brongn.	o-f
Dracophyllum secundum R.Br.	lf-la
Calochilus campestris R.Br.	lf
Cryptostylis longifolia R.Br.	lf
Grevillea laurifolia Sieb.	o
Dampiera Brownii F.v.M.	o
Dianella longifolia R.Br.	o
Marianthus procumbens Benth.	o
Goodenia heterophylla Sm.	o
Stylidium graminifolium Swartz.	o
Bossiaea heterophylla Vent.	o
Bossiaea scolopendria Sm.	o
Monotoca scoparia R.Br.	o
Actinotus Helianthi Labill.	o
Boronia pinnata Sm.	o
Mitrasacme polymorpha R.Br.	o
Helichrysum rutidolepis DC. societies	o
Xerotes flexifolia R.Br.	o
Xerotes longifolia R.Br.	o
Patersonia sericea R.Br.	o-r
Stylidium lineare Swartz.	r-o
Persoonia chamaepitys Cunn.	r-o
Lycopodium densum Labill.	r-o
Symphyonema montanum R.Br.	lo
Hibbertia serpyllifolia R.Br.	lo
Xanthosia pilosa Rudge	lo
Daviesia ulicina Sm.	lo
Marsdenia suaveolens R.Br.	r
Lindsaya linearis Swartz.	r
Panax sambucifolius Sieb.	r
Comesperma ericinum DC.	r
Helichrysum lucidum Henck.	r
Orthoceras stricta R.Br.	r
Smilax glyciphylla Sm.	r
Billardiera scandens Sm.	r
Boronia microphylla Sieb.	r
Trachymene Billardieri F.v.M.	vr
Goodenia decurrens R.Br.	vr
Todea barbara Moore	vr under rocks
Gastrodia sesamoides R.Br.	vr
Creeper.	
Kennedya rubicunda Vent.	r
Parasites.	
Loranthus celastroides Sieb.	o-f
Loranthus pendulus Sieb.	o
Cassytha glabella R.Br.	o

Leptospermum lanigerum *Society.*

The characteristic shrub-stratum of the *Eucalyptus piperita* consociation having been described, it remains to record a smaller shrub society which occurs in this community. In a stagnant depression about one hundred yards in diameter on the south-eastern side of the sandstone plateau, Eucalyptus trees are quite

absent and a dense closed society of *Leptospermum lanigerum* occurs, having the following composition:

Leptospermum lanigerum Sm.	d	
Pteridium aquilinum Kuhn.	c-a	on outskirts
Blechnum discolor Keys.	f	,,
Acacia longifolia Willd.	o	,,
Hydrocotyle asiatica L.	o	,,
Viola hederacea Labill.	o	,,
Clematis aristata R.Br.	o	,,
Panax sambucifolius Sieb.	r	,,

Leptospermum lanigerum is a characteristic of damp and stagnant areas on sandstone. It is interesting to observe that the additional types on the outskirts, with the exception of *Acacia longifolia*, are all components of the *Eucalyptus goniocalyx-E. Blaxlandi* association which occurs at the edge of the basalt; it appears then that these types are governed in their distribution by a comparatively high minimum soil-moisture requirement. *Acacia longifolia*, however, is no doubt precluded by the proximity of the basalt from occurring in the *Eucalyptus goniocalyx-E. Blaxlandi* association.

THE EUCALYPTUS HAEMASTOMA VAR. MICRANTHA CONSOCIATION.

This community is much more restricted in its distribution than the *Eucalyptus piperita* consociation, being confined to ridges and headlands exposed to the west; and, so far as Mount Wilson is concerned, it is limited to the apex of such headlands. In these exposed habitats the soil tends to be swept away by the wind and is consequently shallow and rocky, which is perhaps the main factor preventing occupation by *Eucalyptus piperita*.

Eucalyptus haemastoma var. *micrantha*, while a medium-sized tree in the *E. piperita* consociation, is here stunted and excessively gnarled, its smooth white bark being in distinct contrast to the dark-gray fibrous bark of *E. piperita*.

In habitats where exposure is more moderate, the shrub stratum is very similar in composition to that of the *Eucalyptus piperita* consociation, although of a more open structure. Under more extreme conditions, however, appear a number of highly xerophytic types which seem to be confined to westerly headlands. Their occupation of these habitats is no doubt due to the soil, which is too shallow and rocky for the typical components of the *Eucalyptus piperita* consociation.

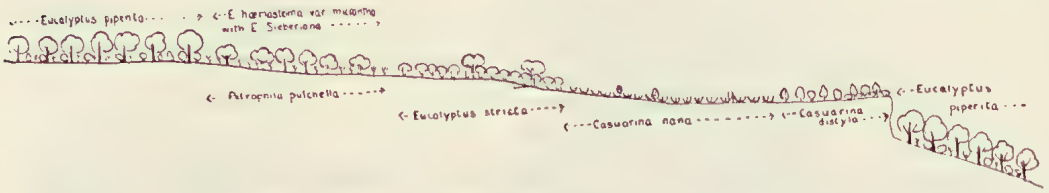
As an example of the occurrence of these types a description is given of the vegetation of the apex of a very exposed westerly headland at Mount Wilson.

THE SHRUB SOCIETIES OF AN EXPOSED HEADLAND.

The sandstone plateau on the western side of Mount Wilson is composed of a series of projecting headlands. Those capped by basalt end in gentle slopes, and their plant-covering has been referred to in Part I and will be dealt with more fully in Part III; the purely sandstone headlands, on the contrary, usually terminate in an escarpment, at the base of which a talus slope extends down into the bed of the Wollangambe River.

Near the apex of one such headland the *Eucalyptus piperita* consociation gives place quite abruptly to that dominated by *E. haemastoma* var. *micrantha*. In the latter community there is first a zone in which *E. Sieberiana* is almost co-dominant and the trees are stunted and more open in structure; after this follows a zone in which the trees become rapidly thinner until they cease altogether at a distance of

several hundred feet from the end of the headland; the shrubs, however, continue on to the top of the escarpment, forming a number of distinct and zoned communities (see Text-fig. 2, and Plate xxi, fig. 6).



Text-fig. 2.—Diagrammatic section (not to scale) of westerly headland at Mount Wilson, showing the distribution of the plant communities.

Beyond the limit of the trees, the shrub communities might be held to have the rank of associations, but since no sharp line can be drawn between those appearing as independent associations and those occurring as a subordinate stratum in the Forest, it is perhaps better to class all the communities as stratum-societies. It must be conceded, however, that the greatest alteration in the nature of the shrubs as they occur in the *Eucalyptus piperita* consociation takes place coincident with the dwindling away of the trees: within the Forest the change is rather that of the elimination of all but those types specially adapted to the more severe environment, the consequent greater abundance of the remainder, and the invasion of some of the new types from societies beyond the trees. The latter are absolutely distinctive and contain only a few types present in the shrub-stratum of the *Eucalyptus piperita* consociation. In these societies the majority of the characteristics are exclusive, being confined to exposed headlands of the highest altitudes of the Blue Mountains: such a restricted range points to a considerable degree of specialisation.

Petrophila pulchella *Society.*

The change in the composition of the shrub-layer as one passes from the *Eucalyptus piperita* consociation leads to the formation of a society dominated by *Petrophila pulchella*. A great many of the former shrub-components of the Forest are here absent, and also certain new types appear as invaders from the communities nearer the edge of the cliff. This society ceases coincidently with the tree-zone. It has a low and heath-like character, no doubt induced by the exposure of the environment (see Plate xxii, fig. 7). The Eucalyptus trees are stunted in this zone and are sparingly scattered, so much so that they are inclined to yield the dominance to the shrub-stratum.

Since this habitat is differentiated by its increased aridity, consequent upon the extreme degree of exposure to the west, and by the closeness of the rock to the surface of the soil, the composition of the *Petrophila* society suggests an interesting clue to the components of the Eucalyptus Forest which are most xerophilous in their adaptations. The majority of the shrubs are excluded; but *Petrophila pulchella* seems well adapted to the habitat, and so has come to dominate the society. Certain other components, such as *Hakea dactyloides*, *Isopogon anemonifolius*, *Banksia ericifolia*, *Trachymene linearis*, *Acacia linifolia* var., etc., likewise can tolerate the conditions, but evidently not so well as *Petrophila*, which has consequently gained a marked ascendancy in the competition among the

species. Amongst the invaders from the adjacent societies at the apex of the headland may be mentioned *Casuarina nana*, *Hakea pugioniformis* and *Leptospermum lanigerum* var. *macrocarpum*.

Floristic Composition.

Shrub Stratum.		Low-Shrub Stratum.	
Petrophila pulchella R.Br.	d	*Baeckea brevifolia* DC.	f
Hakea pugioniformis Cav.	f-c	*Goodenia bellidifolia* Sm.	f
Hakea dactyloides Cav.	f	*Dampiera stricta* R.Br.	f
Banksia ericifolia L.	o-f	*Hibbertia serpyllifolia* R.Br.	f
Casuarina nana Sieb.	o	*Xerotes longifolia* R.Br.	vr
Trachymene linearis Spreng.	o	*Bossiaea* sp.	vr
Acacia linifolia Willd., var.	o	*Leptospermum lanigerum* Sm. var. *macrocarpum* Maiden and Betche	vr
Xanthorrhoea hastilis R.Br.	o		
Pomaderris ledifolia Cunn.	la		
Acacia discolor Willd.	r		

Eucalyptus stricta *Society.*

Immediately below the *Petrophila* society, as the headland begins to slope towards the escarpment, occurs a low, stunted, closed community of *Eucalyptus stricta*, with an occasional tree of *E. haemastoma* var. *micrantha* still present (see Plate xxii, fig. 9). *Eucalyptus stricta* is modified in its life-form by the early proliferation of the stem apex, so that several erect shoots are formed, resulting in a shrubby growth: such trees are locally known as "mallees" in Australia. This character is well marked in the individuals occurring in this community, and, together with the nanism resulting from the exposure of the habitat, causes the plants to attain a height of about only four or five feet. The significance of nanism in the habitat is shown by the fact that *Eucalyptus stricta* in some localities grows to a height of twenty feet.

Under the shelter of the canopy of *Eucalyptus stricta* occur a number of low shrubs, attaining about two feet in height.

Floristic Composition.

Tall-Shrub Stratum.		Low-Shrub Stratum (contd.).	
Eucalyptus stricta Sieb.	d	*Banksia spinulosa* Sm.	o
Hakea dactyloides Cav.	f	*Isopogon anemonifolius* R.Br.	o
Persoonia acerosa Sieb.	o	*Caustis flexuosa* R.Br.	o
Persoonia salicina Pers.	r	*Petrophila pulchella* R.Br.	o
Leptospermum stellatum Cav.	r	*Pomaderris ledifolia* Cunn.	o
		Hibbertia serpyllifolia R.Br.	o
Low-Shrub Stratum.		*Conospermum ericifolium* Sm.	o
Phyllota phylicoides Benth.	f	*Symphyonema montanum* R.Br.	r
Trachymene linearis Spreng.	f	*Xerotes longifolia* R.Br.	r

Casuarina nana *Society.*

Below the *Eucalyptus stricta* society occurs a dwarf-shrub heath composed chiefly of *Casuarina nana*, a stunted, heath-like bush about two feet high. As in a number of these societies, the dominant is not the tallest plant occurring in the community: here the monotony is relieved by an occasional plant of *Casuarina distyla*, a shrub about five feet in height. A few smaller shrubs also stand above the general level, especially *Petrophila*, which is frequent, and which, by its rich green, stands out conspicuously against the brown *Casuarina*. *Eucalyptus* is entirely absent from this wind-swept habitat.

Floristic Composition.

Tall-Shrub Stratum.		Low-Shrub Stratum (contd.).	
Casuarina distyla Vent.	r-o	*Xerotes longifolia* R.Br.	r
		Hakea pugioniformis Cav.	r
Shrub-Stratum.		*Phyllanthus thymoides* Sieb.	r
Petrophila pulchella R.Br.	f		
Trachymene linearis Spreng.	o	Ground Stratum.	
Leptospermum stellatum Cav.	o	*Goodenia bellidifolia* Sm.	a
Hakea dactyloides Cav.	o	*Dampiera stricta* R.Br.	o
		Sowerbaea juncea Sm.	o
Low-Shrub Stratum.		*Hibbertia serpyllifolia* R.Br.	r-f
Casuarina nana Sieb.	d	*Patersonia sericea* R.Br.	r
Isopogon anemonifolius R.Br.	r		

Hakea pugioniformis *Society.*

This is another dwarf-shrub heath of a structure similar to that of the *Casuarina nana* society, and occupying erosion channels intersecting the habitat of that community (see Plate xxii, fig. 8). It is contrasted by its deep-green colour and the terete, pungent-pointed leaves at right angles to the stem, and the angular branching. A few taller types interrupt the closed community of the dominant in places.

Floristic Composition.

Tall-Shrub Stratum.		Shrub Stratum (contd.).	
Eucalyptus stricta Sieb.	r	*Hakea dactyloides* Cav.	o
Leptospermum stellatum Cav.	r	*Cassinia arcuata* R.Br.	r
		Low-Shrub Stratum.	
Shrub Stratum.		*Casuarina nana* Sieb.	r
Hakea pugioniformis Cav.	d	Ground Stratum.	
Banksia ericifolia L.	o	*Goodenia bellidifolia* Sm.	a
Petrophila pulchella R.Br.	o	*Hibbertia serpyllifolia* R.Br.	r

Casuarina distyla *Society.*

Finally, at the very apex of the headland, on a flat area of sandstone rock which has only a shallow layer of soil occurring in pockets and crevices, is found a more open society dominated by *Casuarina distyla*. The majority of the shrubs in this society are only about three feet high, as is the case with the dominants of the two societies just described; *Casuarina distyla*, however, attains a height of about five feet, and thus lends the community a distinctive appearance, a curious fact considering that this appears to be the most unfavourable habitat in the area under consideration.

Floristic Composition.

Tall-Shrub Stratum.		Shrub Stratum—*continued.*	
Casuarina distyla Vent.	d	*Lasiopetalum ferrugineum*	
Eucalyptus stricta Sieb.	o	Sm. var. *cordatum* Benth.	r
Hakea gibbosa Cav.	r		
		Low-Shrub Stratum.	
Shrub Stratum.		*Xanthorrhoea hastilis* R.Br.	o
Petrophila pulchella R.Br.	c	*Leptospermum lanigerum* Sm.	
Banksia ericifolia L.	f	var. *macrocarpum* Maiden	
Cassinia arcuata R.Br.	f	and Betche	o
Hakea dactyloides Cav.	f	*Callitris Muelleri* Benth. and	
Brachyloma daphnoides Benth.	o	Hook. seedlings	o
Leptospermum stellatum Cav.	o	*Casuarina nana* Sieb.	o
Isopogon anemonifolius R.Br.	o	*Acacia suaveolens* Willd.	o
Banksia spinulosa Sm.	o	*Dillwynia floribunda* Sm.	o
Banksia marginata Cav.	o	*Trachymene Billardieri* F.v.M.	o
Hakea pugioniformis Cav.	o	*Persoonia acerosa* Sieb.	vr
Trachymene linearis Spreng.	o		

Floristic Composition—continued.

Ground Stratum.

Hibbertia serpyllifolia R.Br.	f	*Chloanthes stoechadis* R.Br.	r
Dampiera stricta R.Br.	o	*Boronia pinnata* Sm.	r
Symphyonema montanum R.Br.	o	*Pimelia linifolia* Sm.	r
		Xerotes longifolia R.Br.	r

Baeckea brevifolia *Society.*

This is a community of very small types, averaging about a foot in height, and occupying areas on the rocky headland where moisture collects in the soil as a result of drainage from the higher parts of the ridge. It is difficult to realise why this area is not occupied by more of the types belonging to the other communities described, but indeed the sharp lines of demarcation between the societies on this headland have not yet been interpreted apart from the fact that zonation results from increasing exposure and shallowness of soil.

The habitat of this society appears to be a favourable one for orchids, three species being recorded in the following list, although others might probably be found in the proper season.

Floristic Composition.

Low-Shrub Stratum.		Ground Stratum.	
Baeckea brevifolia DC.	d	*Eriochilus autumnalis* R.Br.	a
Isopogon anemonifolius R.Br. seedlings	o	*Prasophyllum densum* Fitzg.	a
Cassinia arcuata R.Br.	o	*Chiloglottis diphylla* R.Br.	f
Eriostemon obovalis Cunn.	o	*Selaginella uliginosa* Spreng.	o
Dillwynia floribunda Sm.	r	*Mitrasacme polymorpha* R.Br.	o
Leptospermum lanigerum Sm. var. *macrocarpum* Maiden and Betche	r	*Drosera spathulata* Labill.	o
Brachyloma daphnoides Benth.	r	*Drosera binata* Labill.	o

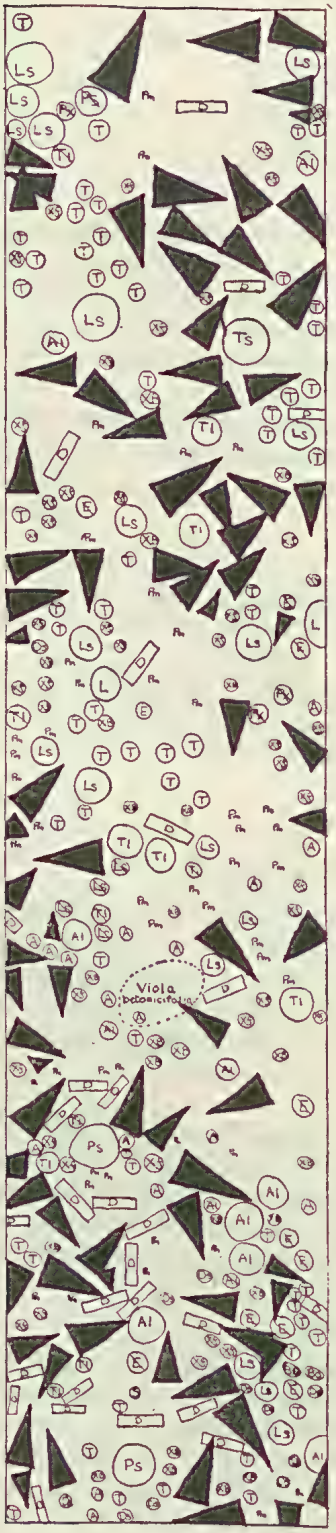
The Stratum-Societies of the Junction Flora.

Some additional observations have to be recorded upon certain of the stratum-societies of the Junction Flora. On the whole the components of these societies are less markedly sclerophyllous than those of the *Eucalyptus piperita-E. haemastoma* var. *micrantha* association of the dry sandstone, which are more extreme xerophytes; this shows how the *E. goniocalyx-E. Blaxlandi* association is an unusually mesophilous Eucalyptus Forest, a fact manifested also by the conspicuous pteridophyte element.

The societies are being dealt with separately here because certain of them are found in the *Eucalyptus piperita* consociation as well as in the *E. goniocalyx-E. Blaxlandi* association. The term *society* is being used in every case rather than *socies*, for, although it is improbable that all the communities are climaxes, the data have not yet been obtained for a clear knowledge of their stability and status.

Pteridium aquilinum *Society.*

We have already seen how the *Eucalyptus goniocalyx-E. Blaxlandi* association occurs as a rule at the periphery of the basalt except on southerly slopes, usually soon giving place, however, to the *Eucalyptus piperita* consociation as it passes on to the edge of the sandstone. The abutting margins of both these communities are occupied by the *Pteridium* stratum-society, as was made clear earlier. A close examination, however, has revealed a distinct difference in the composition of the



Pteridium aquilinum.
Amperea spartioides.
Acacia longifolia.
Dianella sp.
Dampiera stricta.
Eucalyptus piperita.
Leucopogon lanceolatus.
Lomatia silaifolia.
Poranthera microphylla.
Persoonia salicina.
Panax sambucifolius.
Solanum xanthocarpum.
Tetratheca thymifolia.
Trachymene linearis.
Telopea speciosissima.
Xerotes Brownii.
Xerotes flexifolia.

Text-fig. 3.—Belt-transect in the *Pteridium* society of the *Eucalyptus piperita* consociation near the basalt. Regeneration of typical sandstone shrubs is in evidence. (Scale 1 in. = 4 ft.)

subordinates of this society in the two consociations, as will be evident from the appended list and chart. This observation is of great significance, since it constitutes an important step towards the solution of the problem of the status of the *Pteridium* society which was discussed at some length in Part I.

The *Eucalyptus goniocalyx-E. Blaxlandi* association is confined to the damper soil; and it is natural, therefore, that the *Pteridium* society therein should include comparatively mesophilous types. It will be remembered that in this association, beneath the *Alsophila* society, occurs a *Blechnum* stratum-society, which merges into the *Pteridium* society near the outer boundary of the association. These two societies, excluding the *Pteridium* society in the *Eucalyptus piperita* consociation, bear certain resemblances in composition; and there is every reason to believe, not only that the two societies are similar in status, being differentiated owing to different degrees of environmental favourableness, but also that both are climactic. A critical examination of the Belt-Transect in Part I (Text-fig. 5, p. 491), which includes both the *Blechnum* and the *Pteridium* societies, shows that there is no suggestion in either of development to a community of higher status: there is not even a seedling of any type to which *Blechnum* or *Pteridium* could yield dominance. This chart brings out also the general similarity of structure and composition between these two societies. Reference has been made to the fact that the *Pteridium* society shows unmistakable signs of having been burnt out at no remote period; but fires have been observed to have passed through the *Blechnum* society over considerable areas of the *Eucalyptus-Alsophila* Forest; and just as the latter unquestionably regenerates without change in structure, so also no doubt has the *Pteridium* society regenerated, and will regenerate if burnt again.

Let us turn now to a study of the *Pteridium* society in the more typical sandstone habitat of the *Eucalyptus piperita* consociation. Here a remarkable change has taken place in the structure of the society, which is the culmination of a slow transition as we pass from the one consociation to the other: the more mesophilous subordinates, such as *Geranium pilosum*, *Tylophora barbata* and *Stellaria pungens*, have been replaced by xerophytes, notably *Lomatia silaifolia*, *Tetratheca* spp., *Trachymene linearis*, and even an occasional *Persoonia salicina* and *Acacia longifolia*. These features are clearly evinced in the accompanying belt-transect (Text-fig. 3), which forms a most instructive comparison with that to which reference was previously made. The society in the *Eucalyptus piperita* consociation is seen to include quite a number of species of shrubs characteristic of the consociation in its typical expression; and many of these shrubs are found to be in an early stage of renascence from old subterranean rootstocks or else to be in the seedling state.

The importance of this comparison cannot be overestimated, for it has now given the clue to the interpretation of the *Pteridium* society. *Eucalyptus piperita* has been able to establish itself in this habitat close to the basalt: it will be shown in Part III that this species can extend even on to the basalt if freed from competition. The typical shrubs associated with it, however, find greater difficulty in growing here, perhaps because their shallower roots are more exposed to the basalt soil; and, moreover, they are subjected to a severe struggle with *Pteridium*, which finds the habitat not unsuited to its requirements, and which is able to migrate from the *Eucalyptus goniocalyx-E. Blaxlandi* association by the slow but effective agency of its subterranean rhizome.

Now when the Forest is burnt out, *Pteridium* spreads rapidly, and forms the first stage of the subsere. If, as seems to be the case, this is not an ideal habitat

for the sandstone shrubs, renascence and establishment of seedlings will no doubt, in any case, be delayed; and when these processes have to be effected in the face of heavy competition with *Pteridium*, it is easily seen that they will not be performed rapidly. So slow are they that the period between the last two fires in any spot has apparently never been long enough for the next stage of the sere definitely to establish itself, and *Pteridium* is at present the dominant throughout the whole of the Junction Flora. Yet renascence and migration are slowly but surely being accomplished, as is seen in the accompanying transect; although we are unable to state to what this may lead, or what may be the fate of the *Pteridium*. But we are almost safe in concluding that the *Pteridium* community here is neither a climax nor a sub-climax, and perhaps for the sake of distinction we might term it a *Pteridium* socies; and we have undoubtedly made a considerable advance in solving the problem of this somewhat enigmatic tract of vegetation.

Floristic Composition.

These lists represent typical examples of the two extremes of the *Pteridium* society, but it must be understood that there is an extensive ecotone region in which migration of sandstone types is very sparse.

	E. goniocalyx-E. Blaxlandi.	*E. piperita.*
Shrub Stratum.		
Acacia penninervis Sieb.	lo	lo
Acacia longifolia Willd.	—	f
Astrotricha floccosa DC.	—	r-o
Daviesia ulicina Sm.	o	o
Eucalyptus spp. saplings	lf	lf
Leucopogon lanceolatus R.Br.	—	o
Lomatia longifolia R.Br.	—	r
Panax sambucifolius Sieb.	—	o
Persoonia salicina Pers.	—	o
Telopea speciosissima R.Br.	—	o-f
Trachymene linearis Spreng.	—	f-c
Fern Stratum.		
Blechnum cartilagineum Swartz.	a	—
Blechnum discolor Keys.	la	—
Davallia dubia R.Br.	o	o-la
Dianella longifolia R.Br.	f	c-f
Dianella revoluta R.Br.	?	f
Gleichenia dichotoma Hook.	o-c	—
Lomatia silaifolia R.Br.	—	c-a
Phyllanthus thymoides Sieb.	—	lo
Polystichum aculeatum Schott.	lc	—
Pteridium aquilinum Kuhn.	d	d
Xerotes longifolia R.Br.	o	o
Ground Stratum.		
Acaena sanguisorba Vahl.	o	—
Amperea spartioides Brongn.	—	f
Brachycome sp.	o	—
Cardamine hirsuta L.	r-o	—
Chiloglottis formicifera Fitzg.	—	vr
Clematis aristata R.Br. seedlings	r-o	r
Dampiera stricta R.Br.	—	f
Dipodium punctatum R.Br.	—	r
Doodia aspera R.Br.	f	—
Galium umbrosum Sol.	o-la	—
Geranium pilosum Sol.	a	—
Hydrocotyle asiatica L.	o-c	—

Floristic Composition—continued.

	E. goniocalyx-E. Blaxlandi.	*E. piperita.*
Lobelia dentata Cav.	—	r
Lycopodium densum Labill.	—	vr
Mirbelia grandiflora Ait.	—	vr
Oxalis corniculata L.	o	—
Poranthera microphylla Brongn.	r	c
Solanum xanthocarpum Schrad.	—	r-o
Sonchus sp.	—	r
Stackhousia viminea Sm.	—	r
Stellaria pungens Brongn.	c	—
Stellaria flaccida Hook.	f	—
Tetratheca thymifolia Sm.	—	f-a
Tetratheca ericifolia Sm.	—	lf
Trifolium sp.	r	r
Tylophora barbata R.Br.	f	—
Viola betonicifolia Sm.	o-f	o
Wahlenbergia gracilis DC.	—	r
Xerotes flexifolia R.Br.	—	f
Unidentified grasses	f	f
Climbers.		
Hardenbergia monophylla Benth.	—	o
Kennedya rubicunda Vent.	—	f
Smilax australis R.Br.	o	—

Acacia penninervis *Society.*

Reference has already been made to the dense societies of this plant occurring in the Junction Flora. It grows as a tall shrub or sapling in closed societies, such as are characteristic of succession by aggregation following fire. Eventually the plant reaches the height of 30 feet, and in some places groups of such trees are to be seen.

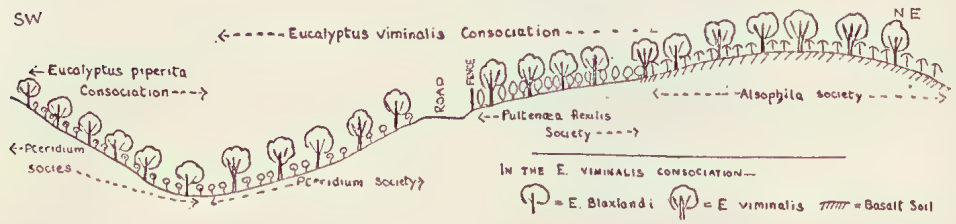
As an interpretation of the presence of these societies we may suppose that an occasional plant of *Acacia penninervis*, originally present in the association, might have preserved its seeds during fire; subsequent colonisation by aggregation from these, unhindered by competition with other species, would result in the local displacement of *Pteridium* and the formation of a dense and almost pure society of the new colonist. The plants, moreover, seem to multiply by the production of shoots from extensive lateral roots, and it may be that in some instances the societies have arisen in this way rather than by aggregation.

Pultenaea flexilis *Society.*

Although practically the whole of the Junction Flora bears the appearance of having been burnt within the last few years, in one place on a gentle south-west slope, a portion of the basalt junction was found inclosed in private land which has evidently not been burnt for a long period. The structure and composition of the vegetation here is of considerable interest, since it shows what the Junction Flora is capable of developing into when unburnt. The community occurs in the *Eucalyptus viminalis* consociation, with *Pultenaea flexilis* subdominant at the sandstone edge, becoming less abundant nearer the tree-ferns. This tall-shrub society extends from the foot of the *Alsophila* society a considerable distance down on to the sandstone; outside the fence flanking a road which has evidently acted as a fire-break, the characteristic *Pteridium* society occurs, as a result of regeneration following a recent fire (see Text-fig. 4).

It cannot be said definitely that the *Pteridium* society would develop to that dominated by *Pultenaea flexilis*; but the comparison of the vegetation on each side of the road shows that it may possibly do so in some parts, and the close resemblance in floristic composition adds support to the view.

Cattle have heavily trampled the ground between the shrubs, which has probably resulted in modifications in the fern stratum.



Text-fig. 4.—Diagrammatic section (not to scale) showing distribution of *Pultenaea flexilis* society.

Floristic Composition.

Tree Stratum.	
Eucalyptus viminalis Labill.	d
Eucalyptus Blaxlandi J.H.M. and R.H.C.	a
Acacia melanoxylon R.Br.	o
Eucalyptus goniocalyx F.v.M.	r
Tall-Shrub Stratum.	
Pultenaea flexilis Sm.	sd-c
Persoonia mollis R.Br.	f (a near tree-ferns)
Daviesia ulicina Sm.	f
Acacia longifolia Willd.	f-o
Citriobatus multiflorus Cunn.	o (a at tree-fern boundary)
Acacia elata Cunn. young plants	r
Leptomeria acida R.Br.	r
Acacia penninervis Sieb.	r at tree-fern boundary
Low-Shrub Stratum.	
Pteridium aquilinum Kuhn.	c-a
Helichrysum rutidolepis DC.	f
Xerotes longifolia R.Br.	f-o
Lomatia silaifolia R.Br.	o
Blechnum cartilagineum Swartz.	o near tree-ferns
Davallia dubia R.Br.	o
Polystichum aculeatum Schott.	o near tree-ferns
Blechnum discolor Keys.	o near tree-ferns
Leucopogon lanceolatus R.Br.	r-o
Ground Stratum.	
Similar to that given in Part I, p. 492	
Dawsonia sp.	r
Acianthus fornicatus R.Br.	r
Creepers.	
Geitonoplesium cymosum Cunn.	o
Billardiera longiflora Labill.	o
Clematis aristata R.Br.	o
Clematis glycinoides DC.	o
Eustrephus Brownii F.v.M.	r

Pultenaea flexilis *Society on Northern and Western Slopes.*

The *Eucalyptus goniocalyx-E. Blaxlandi* association on the edge of the basalt on the westerly slopes, is generally occupied by the *Pteridium* society which was described in Part I (p. 493); societies of *Pultenaea flexilis* occur in addition, however, as was also mentioned therein. On northerly slopes the typical *Pteridium* society supplants the *Alsophila* society in the region of sandstone intermixed with basalt talus, where also are found societies of *Acacia penninervis*. A little further down the slope the *Eucalyptus goniocalyx* consociation, which includes the above societies, suddenly gives place to the *E. piperita* consociation. This community possesses a modification in floristic composition characteristic of its occurrence on sandstone slopes below basalt caps, as will be described in Part III. Along the junction of these two consociations is frequently found a narrow belt of the *Pultenaea flexilis* society, similar in composition to the societies of the western slopes.

The composition of these societies differs somewhat from that of the society on the southwest slope, containing more xerophytic types on account of the greater exposure of the habitat.

The occurrence of these societies of *Pultenaea flexilis* is not easy of explanation. It may be that lack of further disturbance by fire will cause the society to develop in certain areas as a further stage in the sere initiated by the *Pteridium* society; from the conclusions to which we have come regarding the latter community, however, it seems unlikely that this could be at all general. The societies on the northern and western slopes may have arisen by aggregation in the manner suggested for *Acacia penninervis*; but the structure of the society on the southwestern slope shows that this, at any rate, did not originate in this way.

Floristic Composition.

Tall-Shrub Stratum.		Low-Shrub Stratum (contd.).	
Pultenaea flexilis Sm.	d	*Pteridium aquilinum* Kuhn.	c
Callicoma serratifolia Andr.	la	*Xerotes longifolia* R.Br.	f
Telopea speciosissima R.Br.	f	*Trachymene linearis* Spreng.	f
Persoonia salicina Pers.	f	*Acacia juniperina* Willd.	o
Banksia spinulosa Sm.	o	*Dianella* sp.	o
Choretrum Candollei F.v.M.	o	*Xerotes flexifolia* R.Br.	o
Persoonia mollis R.Br.	r	*Amperea spartioides* Brongn.	o
		Davallia dubia R.Br.	o
Low-Shrub Stratum.			
Lomatia silaifolia R.Br.	a-c	Climber.	
Daviesia ulicina Sm.	c	*Eustrephus Brownii* F.v.M.	r

SUMMARY.

1. The paper comprises an account of the Eucalyptus Forests of the plateau at Mount Wilson.

2. A general account of the main features of Eucalyptus Forest is given, and the classification of those occurring at Mount Wilson is placed upon a more permanent basis.

3. Two associations are described, viz., the *Eucalyptus goniocalyx-E. Blaxlandi* association, which includes what were previously called tentatively the *Eucalyptus-Alsophila* association and the *Eucalyptus-Pteridium* association (in part); and the *Eucalyptus piperita-E. haemastoma* var. *micrantha* association, which occupies the dry sandstone plateau. The dominants of both these associations occur always in consociations.

4. The nomenclature and the distribution of the consociations of the *Eucalyptus goniocalyx-E. Blaxlandi* association are discussed; and the structure and physiognomy of the *Eucalyptus piperita-E. haemastoma* var. *micrantha* association is described, special consideration being given to its relation to fires.

5. A description follows of a number of stratum-societies occurring on an exposed westerly headland in the *Eucalyptus haemastoma* var. *micrantha* consociation.

6. In conclusion, some further observations are recorded on the stratum-societies of the Junction Flora, with a special discussion of the status of the *Pteridium* society.

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EXPLANATION OF PLATES XX—XXII.

Plate xx.

1.—The *Eucalyptus goniocalyx* consociation, showing the dominant in the centre and a tall *Alsophila* on the left.

2.—A westerly slope of the sandstone plateau, clothed with the *Eucalyptus piperita* consociation.

Plate xxi.

3.—A portion of the *Eucalyptus piperita* consociation, showing profuse development of shrubs. *Pultenaea scabra* is in the left foreground.

4.—The *Pteridium* society in the *Eucalyptus piperita* consociation near the basalt junction. The trees are seen to be recovering from fire by the production of adventitious shoots on the stems.

5.—A view in the *Eucalyptus viminalis* consociation. The dominant can be distinguished by its white stem, the black trunks being those of *E. Blaxlandi*.

6.—A view on the exposed westerly headland described in the text. The low trees in the background are *Eucalyptus haemastoma* var. *micrantha*, the taller trees being *E. Sieberiana*. The *E. stricta* society is immediately in front of these trees, while the middle distance and foreground are occupied by the *Casuarina nana* society. In the immediate foreground is a plant of *Leptospermum lanigerum* var. *macrocarpum*.

Plate xxii.

7.—The *Petrophila pulchella* society in the *Eucalyptus haemastoma* var. *micrantha* consociation.

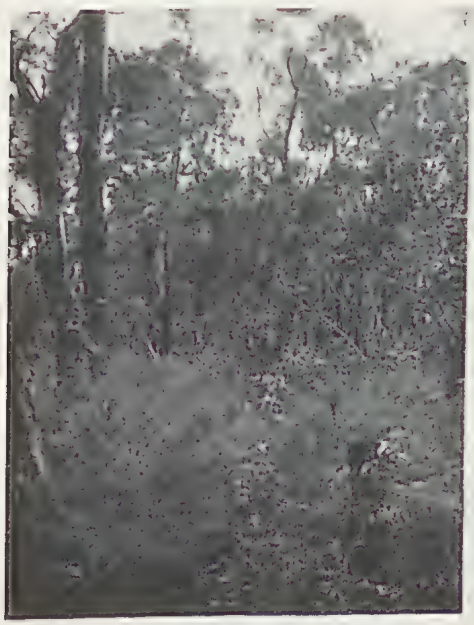
8.—Another view on the exposed westerly headland, showing the *Casuarina nana* society in the foreground, and the *Hakea pugioniformis* society in an erosion channel in the background.

9.—The *Eucalyptus stricta* society. A dead tree of *E. haemastoma* var. *micrantha* is seen in the middle distance.

1 2

1. The *Eucalyptus goniocalyx consociation*, showing the dominant in the centre and a tall *Alsophila* on the left.
2. A westerly slope of the sandstone plateau, clothed with the *Eucalyptus piperita* consociation.

3



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3. A portion of the *Eucalyptus piperita* consociation.
4. The *Pteridium* society in the *Eucalyptus piperita* consociation.
5. A view of the *Eucalyptus viminalis* consociation.
6. View of an exposed westerly headland.

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7. The *Petrophila pulchella* society.
8. View on exposed westerly headland.
9. The *Eucalyptus stricta* society.

BURROWING HABITS OF *ORNITHORHYNCHUS*.

By Harry Burrell, C.M.Z.S.

[Read 27th May, 1925.]

The only published observations of the burrowing of *Ornithorhynchus* are those of the French naturalist-voyager, Jules Verreaux (Observations sur l'Ornithorhynque, *Rev. Zool.* xi, 1848, 127), who spent some time in Tasmania, and claimed to have studied the habits of the animal closely. Unfortunately, Verreaux's account contains so many statements which are not borne out by my subsequent observations that I cannot but regard the whole of it with suspicion.

The interest attaching to precise observations of the actual burrowing method is considerable, the chief point of interest being to determine the relative extent to which the highly sensitive muzzle and the powerful claws of the pes are used in the process. The present observations were made during March of this year upon a single female animal which I had in captivity at my residence in Kensington. The creature was placed in a specially contrived enclosure, the essential features of which were a plate glass front and a wooden back, which were four inches apart at the bottom, widening to six inches at the top, filled with sifted soil, which was put in a bucketful at a time, each bucket of soil being followed by a bucket of water, until the frame was full, when the whole was tamped and thoroughly flooded with water. The object of the taper was to cause the soil to wedge, and so prevent its collapsing on the burrowing animal. Water was used to consolidate the soil to something like the consistency of the banks in which the platypus burrows naturally in the wild state. The enclosure thus prepared was allowed to stand for twenty-four hours, and the animal was then introduced at one side, where a portion of the earth was removed to make room for it, at 2 p.m. No attempt was made to burrow until about 5.30 p.m., but I am not certain whether this time bears any relation to what normally happens. It may be, however, that the animal normally commences its burrowing in the late afternoon. The observations which follow were made during a period of about an hour, by means of the plate glass front, and during this time I kept myself concealed as far as possible from the animal, so as to leave her undisturbed.

The Platypus, in order to obtain the greatest purchase before commencing to burrow, tucks the tapering end of its pliable tail between its hind legs, and, simultaneously, hooks its out-turned hind claws into the earth at either side. While in this crouching attitude, with stiffened top lip and splayed fore-claws, it proceeds smartly to break away the earth, selecting the softest spot available. After burrowing for several inches the animal rests awhile; then it energetically contorts its neck and body systematically, so as to tamp the freshly loosened earth tightly into the otherwise over-large hollow.

While stationary, the creature occasionally beats the surrounding walls with its trowel-like tail. But whether that action is really intended as an auxiliary to

the tamping process, or is simply due to the strenuous exertion of the entire muscular system, or both, I do not profess to know. Nevertheless, it certainly does not distort or tend to break away the true design of a finished burrow by its spasmodic action. In fact, according to the structure and shape of the tail, which, in cross-section, is a miniature replica of that of the tunnel, it could not possibly do so by normal means. Therefore, I suggest that, designedly or otherwise, the tail must be regarded as an actual modelling tool.

After a considerable spell, accompanied by laboured breathing and an occasional gulp in the throat, the operator again deliberately shovels the earth over its head with the end of its sensitive snout. In this way it creates a crude cavity in which to loll its head to one side, while, with the neck fore-shortened, it reaches to the utmost extent of its web-palmed paw, and scratches a hemispherical hollow to one side of the tunnel, contorting its shoulders the while. The energetic digger places its head in the recess so made, and, without any hesitation, performs a similar operation on the opposite side with the other splayed paw. Then, to dislodge the partition separating the two hemispherical recesses which is as yet untouched by the laterally working paws, it probes its muzzle vigorously into that section, thereby completing the circle, and furthermore, creating, as far as the out-stretched neck will permit, another "loll-hole" to one side with its muzzle, in readiness for its head in the shift to follow. Meanwhile, the well-worked earth trickles around the wriggling creature's body, principally about the powerful shoulders, whence a portion eventually filters down as far as the hips.

While the fore-paws and rooting muzzle are working at high tension, the hind legs are, alternately, keeping the specialized fore-parts well up to their work by clinging tenaciously to the solid earth. In their struggle to do this, the hind claws actually aid the process of excavation by cutting the lateral angles which complete the arched design of the burrow.

When the soil so worked has been reduced to tamping consistency, in order to distribute the load, the creature backs down the tunnel to the section previously completed. In so doing, it contorts its entire body, and if hard pressed, spirally so, until the superfluous soil adheres firmly to the hitherto somewhat irregular, roughly cut arch and runway.

Another well-earned rest follows, after which the Platypus again forges ahead, to repeat the burrowing manoeuvrings in their every particular, section after section, until the subway winding from porch to terminal cavity becomes a perfectly-modelled, accomplished fact.

When the animal is confronted with temporary obstacles, such as impoverished, caked earth between roots of trees, etc., in order to avoid retracing its steps to branch off in another direction it will, miner-like, follow the line, not of least resistance, but of favourable soil, even though it be compelled to *work on its back to do so*. The reason it occasionally adopts this upside-down attitude, or any other position, is so that it may dislodge the hitherto unforeseen obstruction by the most serviceable and powerful means, its versatile paws.

Such actions I have critically observed while the creature was manoeuvring in a tight position—this even in the absence of greater obstructions than are occasionally met with, and usually overcome, when a pregnant Platypus is riveting her whole attention on river bank burrowing.

Although it is customary for *Ornithorhynchus* to burrow in a normal position, lying on its back or on either side does not impede its progress in the least. In fact, it seems, at times, to prefer to work in spiral fashion, both while excavat-

ing and tamping its tunnel; but eventually it reverts to the normal attitude to model, accurately, its handicraft. The backward and forward progression of a burrowing Platypus while engaged in tamping is accomplished in separate sections of, approximately, six inches at a time—similar to the sections of pug tamped into position by the tail, prior to the brooding session. But it is not always accomplished in the aforesaid two "mobile" movements. Sometimes, according to the consistency of the soil, the creature will, again and again, repeat the process before relinquishing its arduous duties. Platypus work with a system, entailing detail in every particular.

The reversible action of the animal merits some remarks, especially the backward progression. Students of anatomy will have observed, no doubt, that the hind feet of a Platypus have a tendency to turn outwards from the flanks, and that the grooved, curved claws continue in that symmetrical trend towards the tail. This is as it should be for the purpose of gripping and scratching back surplus soil while the creature is tunnelling ahead. It is also as it should be when the creature reverses. Especially is this so when the animal is burdened with a packing of adhesive pug, and, incidentally, has the auxiliary agency of the front paws practically out of action. Admittedly, the muscular movements of the body at that time afford great assistance. Nevertheless, the hind quarters and cumbersome tail would become useless, if not a burden to the Platypus, during one of its essential functions but for the natural provision of a "two-way" action of the hind limbs. Preparatory to pulling backwards, the trend of the hind feet continues until the sets of claws are facing one another beneath the tail. This stance enables the contortionist to take a firm grip of the flattened earth-floor, so that it can pull the body backwards step by step, while the fore-paws, when freed, do the shoving. Just as the front limbs act alternately in advancing, so do the hind limbs advance in the reverse, and *vice versa*. It is rather amusing to witness this act, for, at the outset, the fore-parts are usually obliterated with pug, and the tail, which in contour and elevation somewhat resembles the head, puts one at a loss to guess whether the creature is really coming or going.

Apart from the claws, the hind foot of *Ornithorhynchus*, especially that of a male, is just as versatile in its actions as that of a chimpanzee, even to the power of deliberately gripping. And this apart from the versatility of the combined actions of the entire limb, which during a backward march resembles, in action and general appearance, the fore-limb of a grizzly bear, or, better still, that of a long-clawed sloth.

The transformation of the *pes* to *manus*, and *vice versa*, is rather deceptive, but readily acquired. Is this not a reptilian trait? What other mammal in the world is able thus to interchange the functions of its hind and front legs to such advantage? It may be characteristic of moles, etc., but it is certainly a remarkable transformation.

So much for the hind limb at present. Now I wish to record further data in connection with the shovelling snout of *Ornithorhynchus*, including the sensitive upper lip.

At the outset of this paper, I unhesitatingly referred to the latter functioning organ as a stiffened upper lip, but not without reason and due consideration. When one handles the foremost part of that lip, it would appear to be almost as limp as its counter-parts. But when the animal is putting it to practical use, viz., rooting into the earth, the position is different. Quite apart from the resiliency of its nature, or whether the creature has the power of temporarily stiffening that

section of its lip at will or not, the solid earth into which it is thrust prevents the lip from falling. At the same time, the lift of the snout arrests any other divergence until the bony prong of the bill is sufficiently embedded in the grooved earth to lever or root the load away. The groove referred to has previously been created, or "lipped in," by a very vigorous oscillation of the animal's head.

During the excavation of a complete burrow of any length, including all cavities, no superfluous earth whatever is ejected. Even the slight disturbance at the initial opening is tramped beyond all recognition as the animal continues to tunnel.

Given favourable conditions, a Platypus can excavate a cavity, approximately $5 \times 5 \times 6$ inches, in five minutes. It can tamp loosened earth, completely, into a six inch section of a tunnel in fifteen minutes. This makes twenty minutes in all to a shift. Therefore, if the tunneller continued unceasingly in this manner, in sixteen hours it would have completed a tunnel twenty-four feet in length. This is the average length of a breeding burrow.

The normal breathing of a Platypus, while asleep, I found to be fifteen respirations to the minute. That of the same healthy specimen, while tunnelling, was thirty to the minute, varied by conspicuous spasmodic gulps in the throat at approximate intervals of twenty-five seconds.

The facial furrows (embracing the orifices of the eyes and ears) are closed throughout the entire proceedings, as is the case when the Platypus is under water.

NEW GENERA AND SPECIES (MOSTLY AUSTRALASIAN) OF BLATTIDAE, WITH NOTES, AND SOME REMARKS ON TEPPER'S TYPES.

By Eland Shaw, M.R.C.S., F.E.S.

(Thirty-three Text-figures.)

[Read 24th June, 1925.]

Recently the good fortune was mine to have in my hands for determination at the one time an unusually large amount of Blattid material, which included the collections of the old Macleay Museum in Sydney, the balance of the Australian Museum collection, some from the South Australian Museum, the whole of the Queensland Museum collection, the Blattidae collected in Australia in 1910-1913 by Dr. Mjöberg and sent to me by Dr. Sjöstedt, the Director of the Stockholm Museum, together with some fresh material of my own. It soon became evident that an examination of Mr. J. G. O. Tepper's Types was most advisable, and, through the courtesy of the Director of the South Australian Museum, I was able to devote a brief holiday to this end, although the time at my disposal was too short to permit of a complete study of them.

The present paper contains proposals for the erection of three new genera, *Elfridaia*, *Tryonicus*, and *Ancaudellia*; with a suggestion for a fourth, *Cutiloidea*; and descriptions of twenty-five species considered to be new to science. With reference to several of Tepper's types notes have been added, which, it is hoped, will be of service in clearing up some doubtful questions; and an attempt has been made to explain some of the peculiarities of structure of the *Panesthiinae*, most strongly evidenced in the earth-digging group.

There are in Australia many undescribed species, chiefly of the subfamily *Pseudomopinae*, and a great deal of work on Australian cockroaches remains to be done. This I had hoped to accomplish, but on account of a breakdown in health, and the changes entailed, it was necessary to cease all regular entomological work, with little hope of taking it up again systematically. My collection was purchased by the Queensland Government, and is now in the Queensland Museum; this paper was practically completed before the transaction took place, but I have altered the numbers of specimens referred to as in my private register to those of the Queensland Museum Register, and all references through the paper to "Coll. auct." should now read Coll. Q. Mus., and to those who entrusted specimens to me I wish to express my regret at my inability to complete the determination of them as I had hoped.

For the drawings for Text-figures Nos. 6 to 11, 13 to 15, 29 to 31, and 33 I have to acknowledge the generous aid of Dr. C. Anderson, of the Australian Museum, and his artist assistant, Miss Joyce K. Allan; and for the drawings for all the others my grateful thanks are due to Mr. Henry Tryon, the distinguished Government Entomologist of Queensland, and his artist assistant, Mr. Helmsing, for without the kindly assistance of these two gentlemen the illustrating of this paper would have had to be abandoned.

AL MUSEUM

The figures, unless the magnification is specified, are much enlarged, but not to a uniform scale.

Subfamily Ectobiinae.

Genus Escala Shelford.

Escala circumducta Walk.

Blatta circumducta Walk., *Cat. Blatt. Brit. Mus.*, 1869, Suppl. p. 142.—*Loboptera circumcincta* Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 37.—*Ischnoptera annulata* Tepp., loc. cit., p. 51.

In a paper of mine (1914) in the *Victorian Naturalist* will be found some notes on this species, but only recently have I had an opportunity to examine Tepper's types, and this examination confirms the opinion then expressed, that Tepper's species was the ♀ of Walker's *Blatta circumducta*. Tepper's types are on one pin, labelled by himself as "Types ♂ and ♀" and "Gilbert River, S. Austr., Sept., '87." Both specimens are ♀, and the vestigial tegmina have disappeared from the lower specimen, the upper one retaining that on the right side, and as Gilbert River is not his type locality this appears to be another instance (Shaw, 1916) where Tepper failed in 1915 to recognize the types from which he wrote his description in 1893.

This species is common in Australia, ranging from Western Australia (Shelford, as *Loboptera circumcincta* Tepp., in *Faun. Sudwest. Austr.*, 1909), through South Australia, Victoria and New South Wales to Queensland. The colour varies somewhat, some specimens in the author's collection from New South Wales and Victoria being pale and showing the brown pronotal marking as a ring enclosing a pale disc, whilst others from Queensland have the general colour much darker and the pronotum almost entirely brown. The ootheca is carried by the female with the suture lateral, the sutural margin being convex and considerably longer than the ginglymoid margin, the divisions for the eggs to the number of about eleven on each side being plainly marked. The eggs do not lie opposite one another, but those of one side opposite the intervals between those of the other side, and each egg is indicated by one of the serrations of the sutural margin. There is little doubt that identical with this species is Tepper's *Ischnoptera annulata*, under which further notes will be found.

Escala longiuscula Walk.

Blatta longiuscula Walk., *Cat. Blatt. Brit. Mus.*, 1869, Suppl. p. 143.—*Ischnoptera obscura* Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 54.

Tepper described *obscura* from a ♀, but the three specimens indicated by him in 1915 as type material are ♂ of *E. longiuscula* Walk.

Subfamily Phyllodromiinae.

Genus Ischnoptera Burmeister.

Ischnoptera paralella Tepp.

Ischnoptera paralella Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 53.

Tepper described this species from a ♀ from Kangaroo Island, and had before him at the same time a ♂ from Beverley, W.A., but I think he must have mistaken it for another ♀ as, when indicating his types in 1915, he labelled it "Cotype" and at the same time labelled as "Type ♂" a specimen obtained by Zeitz from a house in Adelaide in 1914. One of these ♂ should be selected as allotype and described.

ISCHNOPTERA ANNULATA Tepp.

Tepper (1893) described this as from a ♀ only, but in the South Australian Museum there are two ♂ specimens marked by Tepper as his Types. Both of these should be referred to the genus *Escala* Shelf. and, as one of these is labelled "Victoria 3.95," it cannot be his type of 1893, but is probably one of the specimens sent to him by the National Museum, Melbourne, and referred to as No. 4 in his paper of 1895. The other, which I believe to be his type of *annulata*, is really a ♂ of *Escala circumducta* Walk.

ISCHNOPTERA OBSCURA Tepp.

= *Escala longiuscula* Walk. (q.v.).

Genus LOBOPTERA Brunner von Wattenwyl.

LOBOPTERA CIRCUMCINCTA Tepper (1893).

Tepper's types, ♂ and ♀, in the South Australian Museum are both on one pin and, as was presumed by me (1914), are both ♀ of *Escala circumducta* Walk. A careful examination in December, 1922, showed that the upper specimen, which Tepper may have taken for the ♂, has a lobiform tegmen left on one side; and the lower specimen, while showing clear traces of having originally possessed lobiform tegmina, had then lost them both.

LOBOPTERA DUODECEMSIGNATA Tepp. (1893).

I have examined the types in Adelaide, and, although marked ♂ and ♀, they are both female, and further material will probably show that they are the ♀ of an *Escala* Shelf. Tepper described the ♀ only, and his designating a ♂ type in 1915 was probably an error, particularly as it is the example carrying a partly extruded ootheca.

LOBOPTERA HALMATURINA Tepp. (1893).

Tepper's types, ♂ and ♀, are at Adelaide, also some "Cotypes." There is considerable variation in the colour and markings of the abdominal tergites, but the distinctive marks on the thoracic tergites seem to be very constant.

New Locality.—Victoria: Healesville, 1914 (auct).

LOBOPTERA TRICOLOR Tepp.

Loboptera tricolor Tepp., *Horn Exped. Centr. Aust.*, Vol. 2, 1896, 357.

In the South Australian Museum are two specimens labelled in 1915 by Tepper "Type of ♂" and "Type of ♀." The vestigial tegmina of the "Type of ♂" are completely separated, there are no wing vestiges, and the subgenital lamina is large and bears one style on the left side. The specimen labelled "Type of ♀" is a young male larva, obviously an oversight of Tepper's when selecting his types in 1915.

Subfamily EPILAMPRINAE.

Genus ELFRIDAIA nov.

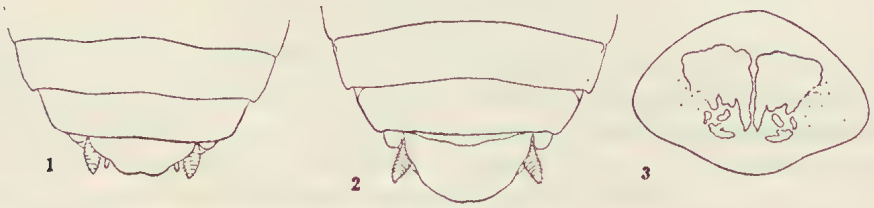
The vertex of the head in both sexes exposed. Pronotum anteriorly truncate, posteriorly straight. Sexes similar. Tegmina vestigial, lateral, squamiform. Wings absent. A spiracular tube projecting on either side of the base of the supra-anal lamina. Subgenital lamina of the ♂ with two styles. Posterior metatarsus about as long as the remaining segments combined, biseriately spined beneath

at the base, pulvillus extending towards the base of the segment; remaining pulvilli large with a prominent apical spine on each side; arolia moderately large. Genicular spines 0.1.1. Apical spines $\frac{1}{1} \cdot \frac{1}{1} \cdot \frac{1}{0}$.

Note.—Near *Opisthoplatia* Brunner v.W., but the vertex is exposed, and there are no vestigial wings.

ELFRIDAIA EBOMAE, n. sp. Text-figs. 1 and 2.

Above rufo-castaneous. Head nigro-castaneous; ocelliform spots small, testaceous; cheeks and mouth parts rufo-testaceous; antennae at least as long as the body. Pronotum finely punctate, the anterior margin truncate, exposing the vertex, posterior margin straight. Tegminal vestiges paler, punctate, squamiform, apex extending to about half-way across the metanotum. Metanotum with the posterior margin medially slightly produced, the postero-lateral angles more produced. Posterior borders of the meso- and metanotum and of abdominal tergites 1 to 7 with a row of indistinct longitudinal raised vittae. Postero-lateral angles of abdominal tergites 1 to 6 slightly backwardly produced, that of tergite 7 not produced. A tube terminating in a spiracle projecting from beneath it at either side.



Text-fig. 1. *Elfridaia ebomae* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

Text-fig. 2. *Elfridaia ebomae* Shaw. ♀. Apex of abdomen, dorsal aspect. Drawn from the allotype.

Text-fig. 3. *Calolampra candidula* Shaw. ♂. Pronotum, showing outline of macula of disc. Drawn from the holotype.

Supra-anal lamina rounded, slightly notched; that of the ♂ (Text-fig. 1) is membranous, whitish, and not so ample as that of the ♀ (Text-fig. 2), which is almost semicircular and castaneous. Subgenital lamina of the ♂ small, rounded, styles situate in a well defined notch; of the ♀ ample, rounded. Beneath rufo-testaceous, darker laterally and distally. Legs with the coxal process (Shaw, 1922) separated from the extremity of the coxal ridge (Shaw, 1922) by a distinct notch; posterior tibia with the spines on the outer aspect triseriately arranged; posterior metatarsus about as long as the remaining segments combined, pulvillus produced towards the base for about three-fourths of the length of the segment in the ♂, not so far in the ♀, biseriately spined beneath, the series being longer in the ♀. Arolia moderately large.

Ootheca.—Membranous, flattened, suture carried laterally, with about fourteen divisions on each side.

Length.—♂, 21 mm.; ♀, 22 mm.

Type material.—Holotype ♂, No. 0/2878. Coll. Q. Mus. Allotype ♀, No. 0/2878*a*. Coll. Q. Mus. Paratypes, 7 ♂, 20 ♀, and 3 oothecae. Coll. Q. Mus.

Habitat.—*Papua*: Samarai (Holotype, Nov., 1914), Eboma Island (remainder of type material, 1914-15) (Auct.).

Genus Calolampra Saussure.

Calolampra candidula, n. sp. Text-fig. 3.

♂. Creamy-white with the pronotum, face and legs a little yellower. Antennae, of rather more than half the body length, with about the proximal one-fourth stramineous, the remainder dark greyish; ocelliform spots white, depressed, larger than the antennary sockets.

Pronotum (Text-fig. 3) with the disc occupied by a prominent black macula, bilaterally symmetrical, and in form suggestive of a swallow-tail butterfly; posterior margin bluntly produced and in two paratypes with a few dark longitudinal striae. Tegmina and wings extending considerably beyond the apex of the abdomen; tegmina with a few small brown maculae situate on the veins. Supra-anal lamina subquadrate, with obtuse angles; cerci long, slender. Subgenital lamina roundly produced, slightly emarginate, bearing two styles. Legs with the coxal processes pearly white; femora not strongly armed; genicular spines 0.1.1; posterior metatarsus longer than the remaining segments combined, biseriately spined beneath for its whole length, and with a few spines on the distal half of each lateral border; pulvillus apical; pulvilli of the remaining segments large, with one or two spines at each side; arolia present.

Length.—27.5-32.0 mm.; tegmen 23.5-28.0 mm.; body 22.0-23.0 mm.

Type material.—Holotype ♂, No. 0/2880. Coll. Q. Mus. Four paratypes, Austr. Mus., S. Austr. Mus., and Q. Mus.

Habitat.—*Queensland*: Bellevue, E. C. Sturtridge, 1917 (Holotype); Aramac, F. Bradshaw, Aug., 1920. *South Australia*: N.E. Corner, F. Parsons.

Note.—This species is near *C. aspera* Tepp., but is much larger, and the black macula of the pronotum is much more prominent. This macula is seen in other species of the genus, and is very constant in form. In *C. irrorata* Fabr. it is well marked in the paler, while obscure in the darker examples. *C. aspera* Tepp., though pale, has the macula obscure, and in the present species it is dense and much more strikingly prominent. One of the paratypes is rather darker than the holotype, and beneath is stramineous with brownish mottling.

Calolampra atra Tepp.

Epilampra atra Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 65.

Tepper (1893) described both sexes, and in 1915 selected two specimens as his types and so labelled them. Both these specimens are ♀, as also is a "Cotype."

Subfamily Blattinae.

Genus Euzosteria Shelford.

Euzosteria purpurascens, n. sp.

♀ closely allied to *E. patula* Walk., but rather larger, much smoother, and of quite different colouring. The rugosity of *patula* is replaced by minute punctures, with a coarse shagreening laterally; and the postero-lateral angles of the thoracic tergites are more produced. The postero-lateral angles of the fifth abdominal tergite are not backwardly produced, those of the sixth tergite scarcely, and those

of the seventh tergite slightly and bluntly produced, not acuminate. Dorsal colour purple-bronze, except the discs of the thoracic tergites which show a green sheen, most marked laterally; the flavid margins of *patula* Walk. are replaced by the purple-bronze; all the tergites to the seventh abdominal bordered posteriorly with yellow, the discs of the thoracic tergites being also bordered laterally by a narrower yellow line; pronotum with the prominent triangular disc completely surrounded by a yellow line. Ventral colour generally rufo-castaneous; thoracic sternites yellow, with numerous small brown maculae; abdominal sternites distally yellowish, and laterally with a green sheen. Legs yellowish beneath, purple-bronze above, spines black; coxal ridges wide; tibiae on their outer aspect flattened, biseriately spined. Subgenital valves of the usual Blattine form.

Length—38.0 mm.

Type material.—Holotype ♀, S. Aust. Mus.

Habitat.—*Northern Territory*: Roper River, N. B. Tindale.

Note.—This very beautiful species I place in the genus *Euzosteria* Shelford, as it is closely allied to *E. patula* Walk., but, if Shelford's character of the biseriately spined outer aspect of the tibia is distinctive of *Polyzosteria*, then both species should be in this genus. In both, the tibiae are more quadrangular than rounded, and, except for a single median spine at each end of the outer aspect, the spines are in two rows only. These two median spines are to be seen in *P. limbata* Burm. and in other species of *Polyzosteria*. The more definitely reflected lateral margins of the pronotum appear to be correlated with the more clearly defined three rows of spines, and a genus intermediate between the two may be necessary when further study has been given to the group.

Euzosteria sordida, n. sp.

♀ dull black above and below, except the discs of the abdominal sternites which are castaneous and shining; the dorsal surface covered with prominent yellow folds or tubercles, being rugose between the tubercles. Head brownish-black, punctate; antennae brown, basal segments darker; palpi yellow. Margins of the thoracic tergites strongly reflected, yellowish with numerous blackish dots and maculae, the latter appear on the inner aspect of the reflected portion. Postero-lateral angles of the fifth abdominal tergite slightly, of sixth more, and of seventh strongly produced backwards. Supra-anal lamina rounded, slightly emarginate, rugose and tuberculate; subgenital lamina with valves of usual Blattine form. Coxae dull black, coxal borders and coxal processes yellow; femora castaneous; tibiae and tarsi yellow with black spines, which on the outer side of the tibiae are triseriately arranged. Claws and arolia brown.

Length.—26.0 mm.

Type material.—Holotype ♀, No. 0/2876. Coll. Q. Mus.

Habitat.—*W. Australia*: Beverley, F. H. du Boulay.

Note.—This is quite distinct from *subverrucosa* White, of which species the Hope Museum kindly gave me a specimen in 1914, and one may assume that Shelford was familiar with the type which is in the British Museum. Little or none of the metallic sheen usual in the genus is shown by this species. There are specimens in the South Australian Museum and in my collection, from South Australia.

EUZOSTERIA TUBERCULATA, n. sp. Text-fig. 4.

Testaceous, prominently and coarsely tuberculate, with dark fuscous or bronze-green in the hollows between the tubercles of the thoracic tergites and some splashes of the same on the abdominal tergites. Head with the vertex and frons brown or almost black, punctate, the line between the epicranial plates and the clypeus being pale and well marked; eyes very prominent; genae testaceous; palpi pale. Thoracic tergites with the lateral margins strongly reflected, pale outside; the dorsal margin of the reflected portion with a row of small brown tubercles, almost serrate; pronotum with prominent symmetrical

Text-fig. 4. *Euzosteria tuberculata* Shaw. ♀. Whole insect (× 3/2). Drawn from the holotype.

tubercles (Text-fig. 4), the anterior one shaped like a *fleur-de-lys*; tubercles of the meso- and metanotum mostly sausage-shaped; of the abdominal tergites, rounded and disposed in almost regular rows. Supra-anal lamina in ♀ rounded, slightly emarginate, subtectiform, darker basally, with several coarse brown tubercles; subgenital lamina in ♀ of the usual Blattine form; cerci short, blunt, flattened, yellow. Beneath smooth, shining; visible parts of the thoracic tergites testaceous; abdominal sternites testaceous, paler at the posterior margins, and fuscous laterally. Legs fuscous; distal portions of the coxae, the knees and the whole of the tibiae and tarsi testaceous, spines black; arolia small.

Length.—Holotype ♀, 29.0 mm.; allotype, larval ♂, 20.0 mm.

Type material.—Holotype ♀, No. 0/2877; and allotype ♂, No. 0/2877*a*, Coll. Q. Mus. Paratypes 3.

Habitat.—*Victoria*: Mallee District, 1918 (Holotype); Lake Hattah (Allotype). *South Australia*: Ooldea and Murray River.

Note.—The projecting eyes, which are very marked in this species, bulging well beyond the general contour of the vertex and genae, are to be found also in some other species of this genus; the smoother species, with but slightly reflected margins of the thoracic tergites, having the eyes not or scarcely projecting. The subgenital lamina of the holotype only is described, the allotype ♂ being a larva. In some examples the ground colour is considerably paler than in the holotype, which is a dark specimen, the larval allotype being very pale in the ground colour, while the dark parts of the legs are almost black. The *fleur-de-lys* shaped tubercle on the pronotum seems quite distinctive of this species.

Genus Leptozosteria Tepper.

Tepper (1893) provisionally proposed this genus for *L. prima*, distinguishing it chiefly by the form of the supra-anal lamina of the ♂ (the only sex he knew), and by the unusual distribution of the colouring. In the following year he added another species, *L. secunda*, from a single ♀, placing it in the genus chiefly on account of the colouring, in which the two have a strong resemblance. Since then, to the genus *Platyzosteria* have been added several other species in which the supra-anal lamina departed as much or more from the usual form, and Tepper himself must have ceased to regard the colouring as diagnostic, or he would have included in the genus *zebra* and *coolgardiensis*, both pale forms with dark bands, especially as the supra-anal lamina of *coolgardiensis* ♂ is backwardly produced. I have examined Tepper's Type of *L. secunda* in the South Australian Museum, and the posterior tarsal structure is that of *Cutilia* Stål, and I have no doubt of the correctness of Shelford's opinion that the species is identical with *Cutilia triangulata* Br. v. W. (q.v.). The posterior tarsal structure of *prima* Tepp. is that of *Platyzosteria*, to which genus I think this species should be referred; and I see no reason for the retention of the genus *Leptozosteria*.

Genus Platyzosteria Brunner v. Wattenwyl.

Platyzosteria armata Tepp. (1893).

Tepper's types in the South Australian Museum were examined by me, and his labels were reversed as to sex. This species was originally described from Western Australia, but the South Australian Museum has now more recent specimens from several localities in South Australia. It belongs to the spinose group, of which the most striking example is *ferox* Shelf., but is of a brownish castaneous colour, and Shelford's (1909) redescription was probably made from a very dark specimen. The posterior metatarsus is of the *Platyzosteria* type, and the points of difference from *P. rufofusca* Tepp. will be found under that species.

Platyzosteria pseudatrata Tepper.

Platyzosteria pseudatrata Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 86.

There is only a single ♂, the type, in the South Australian Museum. Shelford (1909) only knew it by description and was unable to distinguish it from *P. analis* Sauss. or *P. melanaria* Erichs.; but the type does not agree with Shelford's (1909) figures of the latter, nor is it conspecific with what I recognize as *analis* Sauss., the common species in Victoria. It came from Central Australia, and appears to be allied rather to the group whose spininess finds its extreme example in *ferox* Shelf. *P. pseudatrata* is, I believe, a good species; it is apterous, but with some crumpling of the mesonotum laterally, and is very broad in proportion to its length; the 6th and 7th abdominal tergites are laterally serrate, the 7th strongly so and there are prominent spines of the supra-anal lamina; the posterior metatarsus is not long and not spined beneath.

Platyzosteria rufofusca Tepper.

The type, a ♀, and unique, is in the South Australian Museum. Compared with *P. armata* Tepp., it is smaller, not scabrous laterally, and the lateral margins of the 6th and 7th abdominal tergites are not denticulate, but only very finely serrate. The supra-anal lamina, which appears to be slightly deformed, differs in shape, and is not strongly denticulate. The posterior metatarsus is of the *Platyzosteria* type.

PLATYZOSTERIA SCABRELLA Tepper.

The types of ♂ and ♀ are in the South Australian Museum. The posterior metatarsi are short and unspined beneath; the 5th tarsal segment is brownish-yellow; the pale antennae show up very distinctly; and the degree of scabrousness varies in different examples, especially on the pronotum. *P. scabrella* may be taken as representing a group referred to previously by me (1922, p. 224), and the doubtful species then mentioned is here described as *P. anceps*. The little Western Australian species *P. scabrosa*, though not included in the key, is perhaps another member of this group, as may also be *P. variolosa* Bol., a species of which I have no personal knowledge. The following key may be of some service in separating the species of this group.

Key for *P. scabrella* Tepp. group.

(2)	1. Vestigial tegmina present	*bicolor* Kirby.
(1)	2. Entirely apterous.	
(6)	3. Thoracic tergites with shallow pits, not scabrous.	
(5)	4. Orange macula at antero-lateral angle of 7th abdominal tergite.	*babindae* Shaw.
(4)	5. No orange macula	*anceps* Shaw.
(3)	6. Thoracic tergites scabrous.	
(8)	7. Smaller species, antennae ochreous, lateral margins of 6th abdominal tergite not serrate	*scabrella* Tepp.
(7)	8. Larger species, antennae fuscous, lateral margins of 6th abdominal tergite serrate	*scabra* Br. v. W.

PLATYZOSTERIA ANCEPS, n. sp. Text-fig. 5.

Closely allied to *P. babindae* mihi (1922), but has no orange red macula at the antero-lateral angles of the 7th abdominal tergite; is larger, and the subgenital lamina of the ♂ is crenulate (Text-fig. 5). This species is also apterous, but the meso- and metanotum have shallow grooves indicating the position of vestigial tegmina and wings; the lateral margin of the 7th tergite is serrate, as is also that of the 8th abdominal sternite (Text-fig. 5), the last-named character being absent in both *babindae* mihi and *scabrella* Tepp. Differs from *scabrella* Tepp. in the presence of shallow pits of the thoracic tergites, the darker antennae, the presence of lateral grooves of the meso- and metanotum, the shorter subgenital lamina of the male with styles which, though lateral, are more caudally inserted and extend considerably beyond the lamina. The coxal borders are narrowly ochreous, and the tarsi are of the *Platyzosteria* type.

Length.—♂, 21.0-24.0 mm.; ♀, 19.0-22.0 mm.

Type material.—Holotype ♂, No. 0/2892; allotype ♀, No. 0/2892*a*; and 13 paratypes. Coll. Q. Mus.

Habitat.—*Queensland*: Holotype, Upper Burnett District (C. Hogg); allotype, Mt. Forbes, Rosewood (C. Dreveson); Laidley (auct.); Jandowae (R. Illidge); Thulimbah (S. Perriman); Stanthorpe District (H. Jarvis); Childers (J. F. Illingworth); caves near Rockhampton (R. L. Higgins).

Note.—This species was mentioned by me (1922) and examination of a larger amount of material shows that it can readily be separated from *babindae* mihi, and from *scabrella* Tepp., which lie on either side of it.

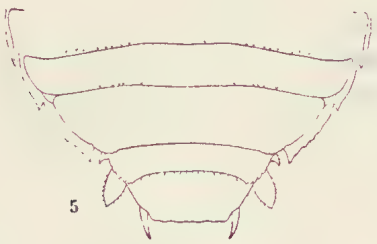
PLATYZOSTERIA BICOLOR Kirby.

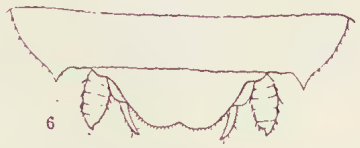
Melanozosteria bicolor Kirby, *Ann. Mag. Nat. Hist.* (7), xii, 1903, p. 373.

New Localities.—*Torres Straits*: Darnley Island; *New Guinea*: Hall Sound. Macleay Mus., Sydney.

PLATYZOSTERIA SCABROSA, n. sp. Text-fig. 6.

Small, black, apterous, densely scabrous. Head with the vertex and frons showing numerous shallow depressions, black, with the margins of the clypeus and labrum rufo-fuscous; antennae yellow, except the three proximal segments,





Text-fig. 5. *Platyzosteria anceps* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from the holotype.

Text-fig. 6. *Platyzosteria scabrosa* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

which are fuscous. Thoracic tergites moderately, and abdominal tergites densely scabrous; lateral margins of the 7th abdominal tergite not serrate, but bearing a few hairs, each springing from a slight elevation; abdominal sternites black, finely scabrous, the distal margins rufo-castaneous.

Supra-anal lamina of the ♂ (Text-fig. 6) subquadrate, emarginate, fimbriate, not so coarsely scabrous as the preceding tergites, tips and ventral surfaces of the cerci dark orange colour; of ♀ similar, more produced and more deeply emarginate. Subgenital lamina of the ♂ transverse, posterior margin faintly concave; styles slender, acuminate, slightly incurved, longer than the lamina and of about the same length as the cerci; of the ♀, the subgenital lamina is of the usual bivalvular form. Legs rufo-castaneous, margins of the coxae narrowly rufous. Metatarsi of the *Platyzosteria* type.

Length.—♂, 10.0 mm.; ♀, 11.5 mm.

Type material.—Holotype ♂ and allotype ♀, Macleay Museum, Sydney.

Habitat.—*Western Australia*: King George's Sound.

Note.—This little cockroach probably belongs to the *scabrella* Tepp. group, with no vestigial tegmina or wings, and a scabrous dorsal surface. Its small size and more scabrous surface distinguish it from *scabra* Br.v.W. and *scabrella* Tepp. Bolivar's species *variolosa*, from New Caledonia, I do not know the size of, but Shelford's (1909) note and figure of it could hardly refer to the present species.

PLATYZOSTERIA JUNGII Tepper.

Periplaneta jungii Tepp., *Trans. Roy. Soc. S. Aust.*, 1895, p. 162.

Tepper described the ♂ and, after examining the type material in the South Australian Museum, I have no doubt of this being quite a distinct species. There were 3 specimens, but Tepper, in indicating his types in 1915, unfortunately selected as the "Type of ♂" an adult ♀ bearing on its label the date 2.1.96, so this obviously could not be the type. Of the other 2 specimens, one was a larval ♂ labelled "Yorktown 30.12.94 A. Jung," and must be selected as the type of the species; the third being another adult ♀, bearing no label, and this

specimen the Museum kindly presented to me, and it is now in my collection. This species belongs to the group which includes *biglumis* Sauss., but to that portion of it without ochreous coxal borders, and is most nearly allied to *P. melanosa*, a species from South-Western Australia, here described as new.

P. jungii Tepp. is very broad, looks like a small *Cutilia nitidia* Br. v. W., but distinguished, not only by its tarsal structure, but by its vestigial tegmina which are not completely separated from the mesonotum, narrow and acuminate, and are produced a little beyond the posterior tergital margin. The ocelliform spots are not seen; the antennae are longer than the body, black for about their distal ⅛, then fuscous; mouth parts black. The distal abdominal tergites have their postero-lateral angles strongly produced backwards and the lateral margins of the 7th not serrate. The supra-anal lamina of the ♀ is triangular, deeply emarginate, with apical serrations. Legs wholly black, posterior metatarsus with pulvillus extending upwards, with strong hairs, some of which appear to be disposed in basal biseriate rows beneath, but they are not spines as in *Cutilia*; ungues black.

PLATYZOSTERIA MELANOSA, n. sp. Text-figs. 7 and 8.

Shining, black, with the exception of the ocelliform spots, the castaneous or fuscous margins of the clypeus and labrum, the castaneous tips of the cerci and the testaceous 5th tarsal segments. Vertex exposed; antennae with the basal segment black, the remainder missing. Vestigial tegmina not completely separated, narrow, acuminate, produced a little beyond the margin of the mesonotum; no wing vestiges.

Text-fig. 7. *Platyzosteria melanosa* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

Text-fig. 8. *Platyzosteria melanosa* Shaw. ♀. Apex of abdomen, dorsal aspect. Drawn from the allotype.

Postero-lateral angles of the distal abdominal tergites strongly backwardly produced, lateral margins of 7th tergite not serrate; supra-anal lamina of the ♂ (Text-fig. 7) subquadrate, widely emarginate, fimbriate, lateral margins everted, three strong spines at each postero-lateral angle, exceeded by the cerci; of the ♀ (Text-fig. 8) triangularly produced, strongly spined all round except towards the base, where there is some eversion of the margin; subgenital valves of the usual Blattine form. Terminal abdominal sternites in both sexes somewhat scabrous. Coxal borders black, posterior metatarsus about as long as the remaining tarsal segments combined, pulvillus produced for about half the length of the segment, with a few short hairs basally.

Length.—♂, 22.0 mm.; ♀, 24.0 mm.

Type material.—Holotype ♂, No. K45547, and allotype ♀, No. K51764. Australian Museum, Sydney.

Habitat.—Western Australia: Michaelmas Is., King George's Sound (Troughton, Grant and Wright, 21.11.21).

Note.—This species belongs to the group of *P. biglumis* Sauss. with only partly separated tegminal vestiges, and to that section of this group without pale coxal borders. It is larger than *biloba* Sauss. and *perplexa* Shelf., and has not the peculiar structure nor the long cerci of *curiosa* Shelf., but the last species, as Shelford thought possible, may have been described from a larva. *P. melanosa* is most nearly allied to *P. jungii* Tepp., being of about the same length, but of a markedly narrower shape, has a few small departures from the uniform blackness of that species, and the supra-anal lamina of the ♀ is of a quite different form.

Platyzosteria ardrossanensis Tepp. (1893).

A synonym of *Zonioploca alutacea* Stål (q.v.).

Tepper's "Type of ♀," as indicated by him in 1915, is labelled "Goolwa." This is evidently an error, as Ardrossan is the only locality mentioned in the original description; but a ♀ amongst the "Cotypes" bears an old label "Ardrossan 26-2-85"; and was no doubt his type of ♀.

Platyzosteria avocaensis Tepp.

Tepper (1893) described the ♀ only, but in 1915 he selected, in addition to his "Type of ♀," a specimen which he labelled "Type of ♂." This, while probably conspecific with the type of ♀, is not adult, but really a larval ♀. The type of ♀ is distinct from *castanea* Br.v.W., being larger, apterous, the lateral margins of the 7th abdominal tergite are serrate, and the ootheca is smooth, while that of *castanea* is prominently longitudinally keeled as shown by specimen No. 272 in my collection.

Platyzosteria exaspera Tepper (1894).

Tepper (1894) described the ♂ only, but there is confusion here also with regard to his types. In 1915, he selected, in addition, a "Type of ♀," using a specimen which reached him after the date of the publication of his paper. I am unable to separate either of these from *castanea* Br.v.W., and although Shelford appeared to consider both *avocaensis* Tepp. and *exaspera* Tepp. identical with *castanea* Br.v.W., examination of the types convinces me that *avocaensis* at least is a separate species.

Platyzosteria provisionalis Tepper.

Periplaneta provisionalis Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 108; 1895, p. 161.—*Syntomaptera provisionalis* Tepp., Kirby *Syn. Cat. Orth. Brit. Mus.*, 1, 1904, p. 130.—*Platyzosteria provisionalis* Tepp., Shelford, *Trans. Ent. Soc. Lond.*, 1909, p. 282.

With regard to the type of this species, there are two specimens in the Type Collection of the South Australian Museum selected and marked as type material by Tepper in 1915, more than twenty years after he had described the species, and after he had left the Museum. As he was then a very old man there is little wonder that numerous mistakes occurred in the selection of the types, and the matter has already been alluded to by me (1916) when dealing with the types of *Ischnoptera brunneonigra* Tepp. The two specimens referred to are not conspecific, that which he selected and labelled as "Type of ♀" also bearing old labels, giving Torrens Creek as locality, the date 1894, and the designation

"♂ nymph." It is really a ♂, apterous, and has the posterior metatarsi spined beneath. The second specimen, labelled in 1915 as "Cotype," bears also a label "Mt. Bryan E. 4.6.87. T. Best." It is an adult ♀, 12 mm. long, with long narrow tegminal vestiges, and the posterior metatarsi missing. I consider this should be indicated as the holotype of *provisionalis* Tepp., the first specimen being an undetermined *Cutilia*.

PLATYZOSTERIA ALBOMARGINATA Br. v. W.

This species will probably be found widely spread from Western Australia through South and Central Australia to New South Wales, but I have no records from Victoria. Brunner (1865) gave a meagre description of the larval ♂, but Shelford (1909) added more details and figured the apex of the abdomen of the ♂. The supra-anal lamina of the ♀ is of a form almost identical with that of the ♂, but I think Shelford's figure errs in representing the lateral margins of the 7th tergite as so coarsely serrate. The posterior metatarsus is shorter than the remaining segments combined, unspined beneath, and with a pulvillus extending proximally. The diagnostic points between this and the following species, *brunnea* Tepp., will be found under the latter. In some specimens the prominent white lateral border of the thoracic tergites is almost obsolete, only showing as a short narrow streak on the pronotum, and as a small dash or spot on the meso- and metanotum.

New Localities.—South Australia: Pungonda (A. Dubbe), Kangaroo Island (A. M. Lea), Murray River (H. S. Cope), Ooldea (A. M. Lea). S. Aust. Mus.

Key for *P. albomarginata* Br. v. W. group.

(8)	1. Pale border not extending round the abdomen.	
(3)	2. Small species (15.0 mm.)	*inclusa* Walker.
(2)	3. Larger species.	
(5)	4. Posterior margin of seventh tergite sinuate	*variegata* Shelf.
(4)	5. Posterior margin of seventh tergite not sinuate.	
(7)	6. Abdomen tapering caudally	*albomarginata* Br. v. W.
(6)	7. Abdomen broad caudally	*brunnea* Tepp.
(1)	8. Pale border extending round the abdomen.	
(10)	9. Strongly spined caudally	*spenceri* Shelf.
(9)	10. Not so	*obscuripes* Tepp.

PLATYZOSTERIA BRUNNEA Tepper (1893).

An examination of Tepper's type material in the South Australian Museum showed that is consisted of four specimens marked by Tepper in 1915, "Type of ♂, Type of ♀. Cotypes ♂ and ♀." The "Type of ♂" was a ♀ of *P. communis* Tepp. with a locality label "Brighton" attached, and was removed at my instance by the Museum entomologist. The three other specimens were larval ♀, the one selected as "Type of ♀" being one of the original Gilbert River examples, dated "L. Molineaux 30.5.87.", and should be recognized as the holotype of the species. Capt. S. A. White has since brought in several specimens, including males, from Central Australia, and one of these should be selected as the allotype ♂, unless Tepper's real type of ♂ can be found. This species differs considerably from *albomarginata* Br. v. W., although it belongs to the same group of *Platyzosteria*, that is, those with a flavid lateral border but no tegminal vestiges. The abdomen of *albomarginata* Br. v. W. tapers gradually towards the apex, whilst in *brunnea* Tepp. the 6th tergite is as wide as the 5th, and only a little wider than the 7th, the postero-lateral angles of which are very strongly backwardly produced,

and relatively wide apart. The lateral margins of the 7th abdominal tergite are strongly serrate in *brunnea* Tepp. and but faintly in *albomarginata* Br. v. W., and there is a definite thickening of the lateral borders of the abdominal tergites in the former, which the latter does not show. The cerci of *albomarginata* Br. v. W. are relatively much longer than those of *brunnea* Tepp. In colouring also the two differ, for whilst *albomarginata* Br. v. W. is almost black, *brunnea* Tepp. is brown, and has a broader flavid margin.*

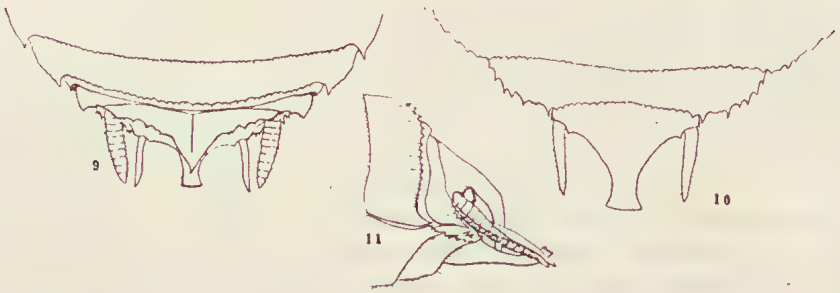
PLATYZOSTERIA SUBMARGINATA Tepper.

Drymaplaneta submarginata Tepp., *Trans. Roy. Soc. S. Aust.*, xvii, 1893, p. 11.

Shelford (1909) regarded this species as identical with *P. circumducta* Walk., but while that species will probably prove to be a *Cutilia* Stål, an examination of Tepper's types of *submarginata* show it to be a true *Platyzosteria*. The larval ♀ which Tepper describes, and gives the length of as 21 mm., I was unable to trace in the South Australian Museum.

PLATYZOSTERIA RUGOSA, n. sp. Text-figs. 9, 10 and 11.

♂ apterous, nigro-castaneous. Dorsal surface densely and coarsely punctate. Head black; ocelli orange, minute; margins of the clypeus, and of the emarginate labrum pale; antennae longer than the body, black. Pronotum almost concealing the vertex, posterior margin straight, broadly bordered with orange-yellow except in the middle third where the castaneous disc reaches it; meso- and metanotum with the postero-lateral angles slightly produced, the outer fourth of the former and the outer fifth of the latter being orange-yellow. Abdomen slightly wider than the thorax; tergites 5, 6 and 7 with the postero-lateral angles produced; tergite 8 with the postero-lateral angles bearing spiracles; tergite 9 with the angles serrate posteriorly; tergites 6 and 7 with the posterior margins crenulate and serrate respectively; supra-anal lamina (Text-figs. 9 and 11) triangular, the lateral margins



Text-fig. 9. *Platyzosteria rugosa* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

Text-fig. 10. *Platyzosteria rugosa* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from the holotype.

Text-fig. 11. *Platyzosteria rugosa* Shaw. ♂. Apex of abdomen, lateral aspect. Drawn from the holotype.

serrate at the base, apex produced into a long, sharp, deflected spine, medially carinate at the base; subgenital lamina (Text-fig. 10) produced into a long, flattened, slightly reflected process whose apex, about 0.75 mm. wide, is crenulate;

* Since writing the above I find that Mr. N. B. Tindale (1923) has published a figure of the holotype ♀ ; and a figure, with some descriptive notes, of a ♂ from Pearson Island.

styles about the length of the lamina, acuminate, with a short spine within the base; cerci long. Abdomen beneath smooth, nitid, nearly black, sternites 7 and 8 with the posterior angles and the outer portions of the posterior margins serrate. Legs black; coxae very narrowly margined yellow; posterior metatarsus long, unspined beneath, pulvillus occupying the whole segment. Other tarsal segments unspined, with large pulvilli. Arolia present.

Length.—25.0 mm.

Type material.—Holotype ♂, South Australian Museum.

Habitat.—*Northern Territory*: Mary River (W. D. Dodd).

Note.—The spinose distal tergites and sternites and the extended supra-anal lamina resemble those of *Leptozosteria prima* Tepper, but the texture of the dorsal surface and the form of the subgenital lamina are very different, and I leave this species in the genus *Platyzosteria* for the present. This unique specimen is a striking and handsome cockroach, and it will be interesting to see further material.

PLATYZOSTERIA CINGULATA Shaw.

Platyzosteria cingulata Shaw. PROC. LINN. SOC. N. S. WALES, xlvii, 1922, p. 226.

New Locality.—*Queensland*: Toowoomba (H. Longman). Coll. Q. Mus.

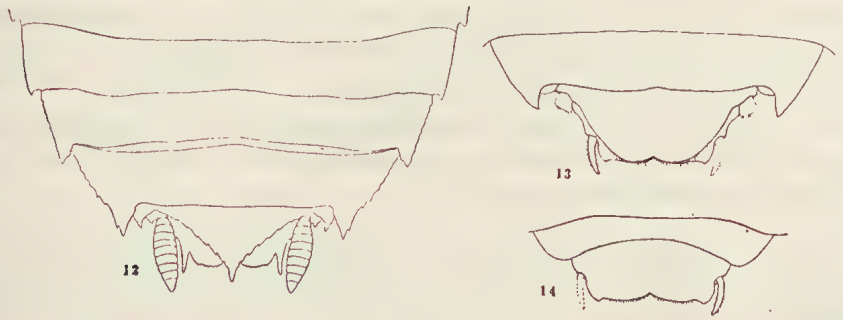
PLATYZOSTERIA CURIOSA Shelford.

Platyzosteria curiosa Shelf., *Faun. Sudwest. Aust.*, Bd. ii, Lief 9, 1909, p. 135, Plate xiii, figs. 11, 12.

Described from a single ♀ from Northam, Western Australia, and Shelford mentions as doubtful a second specimen in the Hope Museum. In 1920 the late F. P. Spry gave me a ♀ (No. 230 Coll. Shaw), with ootheca attached, which I refer to this species. No locality was obtained, but doubtless it was Australian. The insect is much depressed, as is also the ootheca, which is carried suture dorsally; the suture as far as visible showing no serrations. In my specimen the supra-anal lamina is not dentate all round as shown in Shelford's figure, but only about the apex, the remainder being spined.

PLATYZOSTERIA PRIMA Tepper. Text-fig. 12.

Leptozosteria prima Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 96.—*Platyzosteria aposematica* Shelf., *Trans. Ent. Soc. Lond.*, 1909, p. 288.



Text-fig. 12. *Platyzosteria prima* Tepper. ♂. Apex of abdomen, dorsal aspect. Drawn from No. 0/2902, Coll. Q. Mus.

Text-fig. 13. *Zonioploca bicolor* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

Text-fig. 14. *Zonioploca bicolor* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from the holotype.

I have examined all the specimens enumerated below, and I think they will be found to be examples of a species having a considerable range of variation in both size and colouring. The dark markings on the thoracic tergites do not always display a pale discal portion; but all the examples have a very depressed form, a spinosity of the terminal abdominal segments, and a similar form of the terminal laminae in each sex. In all, also, the form of the posterior tarsus is the same, and is that of *Platyzosteria*. Tepper described *prima* from a single ♂, and Shelford *aposematica* from a single ♀, giving a good figure. Both are recorded from Central Australia, as are also White's specimen, and the remaining two from the fringe of that area taken in the faunistic sense. As the ♂ has never been figured the apex of the abdomen is shown in Text-fig. 12.

Habitat.—Central Australia: ♂, Type of *L. prima* Tepp.; Spencer-Gillen Exped. 1889. ♀, Type of *aposematica* Shelf. (Nat. Mus. Melb.); Capt. S. A. White (Adelaide Mus.). *Queensland*: Winton, 1912, ♂, Higgins (Q. Mus.); Aramac, 1920, larval ♀ (Austr. Mus., Sydney, No. K43406).

SYNTOMAPTERA GLABRA Tepper.

Syntomaptera (*Periplaneta*) *glabra* Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 107.

There are five specimens under this name in the South Australian Museum. All are ♀ and of these, three labelled "N. Territory, Pulleine" (not Magarey) are of an apterous *Cutilia*, with typically spined posterior metatarsus; certainly not Walker's *Periplaneta glabra*, nor *Platyzosteria aterrima* Erichs. (teste Shelford, 1909); but probably either Tepper's *parva* or an allied undescribed species. The other two specimens are of a true *Platyzosteria*, with vestigial tegmina and yellow margined coxae, not *aterrima* Erichs., which is apterous, and not *parva* Tepp., which is a *Cutilia;* but may be the ♀ of *glabra* Walker, of which the ♂ only was described. All these specimens are ♀, and it is unwise to be definite about them, but in any case neither of the two specimens of *Platyzosteria* can be the type of *glabra* Tepper, as they did not reach him until months after his description of that species was published.

Genus ZONIOPLOCA Stål.

ZONIOPLOCA ALUTACEA Stål.

Zonioploca alutacea Stål, *Bih. Svensk. Akad.* ii (13), 1874, p. 13.—*Platyzosteria ardrossanensis* Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 92.

Shelford (1909) saw Stål's type and found that Tepper's description of *ardrossanensis* "corresponded perfectly" with it.

New Localities.—South Australia: Goolwa, Tepper (South Australian Mus.), Myponga, A. H. Elston (Coll. auct.). *Western Australia*: Mullewa, 1914; Cunderdin, 1913-14 (S.A. Mus. and Coll. auct.).

ZONIOPLOCA BICOLOR, n. sp. Text-figs. 13 and 14.

Ochraceous. So densely covered with reddish-brown granules that, except at the thickened margins of the pronotum, the dorsal ground colour is scarcely visible. Head ochraceous, granulate, antennae reddish-brown, paler proximally. A short thick yellow streak extending backwards and outwards about the middle of each lateral half of the meso- and metanotum; these streaks appear on the abdominal tergites as irregularly shaped maculae; beneath sordid testaceous, not granulate. Legs with most of the dorsal aspect of the coxae and femora shining

black, and that of the tibiae rufo-castaneous, and of the tarsi partly black, ventral aspect of the legs concolorous. Coxal borders pale yellow on both aspects. Posterior metatarsus about as long as the remaining segments combined, unspined beneath, pulvillus apical, arolia large. Supra-anal lamina ♂ (Text-fig. 13) large, rounded, very faintly emarginate, fimbriate, cerci broken off. Subgenital lamina ♂ (Text-fig. 14) subquadrate, angles obtuse; styles lateral, long, acuminate.

Length.—♂, 17.0 mm.; ♀, 22.0 mm.

Type material.—Holotype ♂, No. K45509; and allotype ♀, No. K45510, Australian Mus., Sydney.

Habitat.—*Western Australia*: Cranbrook (Troughton and Wright).

Note.—This species is much like *Z. medilinea* Tepp., without the black stripe, or granulose sternites; but the legs are more like those of *alutacea* Stål and *pallida* Shelf. They differ, however, in their striking colouring, whilst the ventral aspect of the legs is inconspicuous, the dorsal aspect, with the black and yellow coxae and femora, castaneous tibiae, and parti-coloured tarsi, would afford a startling spectacle should these cockroaches assume for defence the tilted forward attitude noted by me (1914) as used by *Platyzosteria castanea* Br. v. W. (but in that note I wrote "ventral" for dorsal). The leg colouring of this and other species supports the idea that the attitude may be employed by many cockroaches, and may account for the frequently found pale coxal borders.

Zonioploca dixoni Shaw.

Zonioploca dixoni Shaw, Proc. Linn. Soc. N. S. Wales, xlvii, Pt. 3, 1922, p. 231.

This species was described by me as new, and placed with some reservation in *Zonioploca* Stål; but since examining Tepper's type of his *Lepidophora furcata* in the South Australian Museum, I have no doubt but that the two are identical, and my name therefore becomes a synonym of his (vide *Eppertia furcata* Tepp.).

Zonioploca latizona Tepper.

Platyzosteria latizona Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 92.

Shelford (1909) was uncertain as to the position of this species, but an examination of Tepper's types shows it to be a *Zonioploca*, probably near *robusta* Shelf., but smaller. The types, ♂ and ♀, are in the South Australian Museum, and a "Cotype" kindly presented to me by the Museum, is in the Queensland Museum collection, No. O.2856.

Genus Eppertia, nov.

Eppertia furcata Tepper.

Lepidophora furcata Tepp., *Trans. Roy. Soc. S. Aust.*, 1895, p. 21; *Report Horn Exped. Cent. Aust.*, 1896, p. 363.—*Tepperia furcata* Kirby, *Syn. Cat. Orth. Brit. Mus.* (Additions and Corrections to Vol. i), Vol. iii, 1910, p. 565.—*Zonioploca dixoni* Shaw, Proc. Linn. Soc. N. S. Wales, xlvii, Pt. 3, 1922, p. 231.

Tepper described this species from a ♂ taken at Lake Callabonna in South Australia. His type is in the South Australian Museum, marked as such by himself, and the Museum possesses a second ♂ captured at Oodnadatta, Central Australia, and mentioned by Tepper in the Report of the Horn Expedition. This specimen is also marked "Type" in Tepper's writing, evidently an error, as it was

not captured until some years later, and the Horn Expedition Report was not published until more than a year later than the original description. The next known of the insect was when the late F. P. Spry sent me specimens from the Victorian Mallee and from South and Central Australia, and not recognizing it as Tepper's *Lepidophora furcata*, I (1922) described it as *Zonioploca dixoni;* but an examination of Tepper's type showed me my error. Tepper thought it was a Perisphaeriine, never having seen the ♀, but my ♀ (the allotype) and a ♀ returned to Mr. Spry have the subgenital lamina of the usual Blattine form, and I think the genus should come after *Zonioploca* Stål. Kirby followed Tepper in placing it in the Perisphaeriinae. The "scale like appendage" to which Tepper (1895) refers, and from which he took his generic name, is not, as he stated, parts of the abdominal tergites, but unusually large pleural plates bearing at their postero-lateral angles the hard ring-like tracheal openings. These, of course, are found in all cockroaches, and may be plainly seen in *Scabina*, *Anamesia*, and *Zonioploca*, and probably in many others. The largest known to me are those in the present species, and those nearer the thorax are larger than those more caudally situate.

In the type the subgenital lamina is shorter than in the Oodnadatta specimen, or in the ♂ in my collection. It may be deformed, as the subgenital lamina frequently is, notably in *Cosmozosteria*, and is evidently variable, as my specimen bears an internal tooth on the divergent spines which is absent in the others.

Tepper's generic name *Lepidophora* was used in Diptera by Westwood in 1835, so Kirby, in 1910, renamed the genus *Tepperia;* but *Tepperia* had already been used by A. M. Lea in 1903 for a genus of Curculionidae (Proc. Linn. Soc. N. S. Wales xxviii, 1903, p. 660), and a new genus is therefore needed to replace Kirby's. I would propose *Eppertia*, hoping thereby to preserve Kirby's compliment to Tepper.

Genus Cutilia Stål.

Key to Cutilia.

(34)	1. Not transversely banded.	
(29)	2. Possessing vestigial tegmina.	
(26)	3. Vestigial tegmina lobiform, subgenital lamina of the ♂ symmetrical.	
(19)	4. Not margined pale laterally.	
(18)	5. Legs not testaceous.	
(9)	6. Tegminal vestiges obliquely truncate.	
(8)	7. Large, relatively broad, legs black, ootheca smooth	*nitida* Br. v. W.
(7)	8. Smaller, not relatively broad, legs castaneous and rufous, ootheca fluted	*nitidella* Shaw.
(6)	9. Tegminal vestiges more or less tapering, not obliquely truncate.	
(11)	10. Dorsum tuberculate	*obscura* Tepp.
(10)	11. Dorsum not tuberculate.	
(15)	12. Spine at base of genital styles.	
(14)	13. Tegminal vestiges narrow, tapering sharply	*kellyi* Shaw.
(13)	14. Tegminal vestiges broad, tapering roundly	*brevitarsis* Shaw.
(12)	15. No spine at base of genital styles.	
(17)	16. Small size (about 17.0 mm.), subgenital lamina of ♂ with posterior margin straight	*scabriuscula* Tepp.
(16)	17. Large size (about 27.0 mm.), subgenital lamina of ♂ with posterior margin convex	*insularis* Shaw, MS.
(5)	18. Legs testaceous	*melanesiae* Shelf.
(4)	19. Margined pale laterally.	

(23) 20. Testaceous or ferruginous.
(22) 21. Postero-lateral angles of the distal abdominal tergites of ♂ produced ..... *heydeniana* Sauss.
(21) 22. Not so ..... *sedilloti* Bol.
(20) 23. Castaneous.
(25) 24. Spine at the base of genital styles ..... *philpotti* Shaw.
(24) 25. No spine at the base of genital styles ..... *communis* Tepp.
(3) 26. Vestigial tegmina not free at the tips, but represented by a sulcus; subgenital lamina of ♂ asymmetrical.
(28) 27. Margined pale laterally ..... *uncinata* Shaw.
(27) 28. Not margined pale laterally ..... *illingworthi* Shaw.
(2) 29. Apterous.
(31) 30. Margined pale laterally ..... *tepperi* Shaw.
(30) 31. Not margined pale laterally.
(33) 32. Ferruginous ..... *spryi* Shaw.
(32) 33. Piceous ..... *parva* Tepp.
(1) 34. Transversely banded.
(38) 35. Nigro-castaneous, banded pale.
(37) 36. Large species (about 22 mm.), with broad interrupted fasciae of thorax ..... *subbifasciata* Tepp.
(36) 37. Small species (about 12 mm.), abdominal tergites 8 and 9 only banded ..... *feriarum* Shaw.
(35) 38. Testaceous, banded dark.
(40) 39. Disc of pronotum with 3 fuscous vittae arranged triangularly, tegminal vestiges completely separated ..... *secunda* Tepp.
(39) 40. Disc of pronotum with large black central macula, tegminal vestiges not completely separated ..... *nigrofasciata* Shaw.
Species incertae sedis ..... *brunni* Alfk.

Cutilia obscura Tepper.

Periplaneta obscura Tepp., *Trans. Roy. Soc. S. Aust.* xvii, 1893, p. 107.—Not *Platyzosteria obscura* Tepp., Shelford, *Trans. Ent. Soc. London*, 1909, p. 280, Pl. viii, Fig. 19; *Faun. Sudwest. Austr.* ii, Lief 9, 1909, p. 135.

I have examined Tepper's type in the South Australian Museum, and it is certainly a *Cutilia* Stål, the caudal metatarsi being typical; the tergites, except the pronotum, are tuberculate; the coxal borders are concolorous; the vestigial tegmina are complete; and the tips of the valves of the subgenital lamina are visible dorsally. Shelford's description of the Western Australian ♂ which he supposed to be of this species, was probably written from quite a different cockroach. He would hardly have overlooked the tarsal structure, or the tuberculate tergites; and while Tepper's species is but 15.0 mm., Shelford's is over 20.0 mm. long, and has pale bordered coxae. Tepper's species appears to be a good one, and differs from any other *Cutilia* known to me.

Cutilia scabriuscula Tepper.

Periplaneta scabriuscula Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 108.—*Syntomaptera scabriuscula* Tepp., Kirby, *Syn. Cat. Orth. Brit. Mus.*, i, 1904, p. 130.—*Platyzosteria scabriuscula* Tepp., Shelford, *Trans. Ent. Soc. London*, 1909, p. 280.

A good species, widely distributed from Western Australia to Victoria; but an examination of Tepper's types in the South Australian Museum shows that the posterior metatarsus is longer than the remaining segments combined, is biseriately spined beneath, and has an apical pulvillus; and that the species should go into Stål's genus *Cutilia*. Mr. A. M. Lea has taken the species from ants' nests at Port Lincoln and Goudie, South Australia.

Cutilia tepperi Shaw.

Cutilia tepperi Shaw, *Mem. Q. Mus.* vi, 1918, p. 157.—*Drymaplaneta circumcincta* Tepp. MS.

I examined Tepper's types of *circumcincta* in the South Australian Museum. There are two specimens labelled by him "Type of ♂", and "Type of ♀". These are both ♀, and were relabelled by me. I could find no records, and I think it is clear that he never published any description under his MS. name.

Cutilia communis Tepp.

Drymaplaneta communis Tepp., *Trans. Roy. Soc. S. Aust.* xvii, 1893, p. 110.—*Methana antipodum* Brancsik, *Jahr. ver. Trencsin. Com.* xix-xx, 1897, p. 58, Pl. i, fig. 4 (teste Shelford).

I have examined Tepper's types in Adelaide, and these agree with his description and type localities; but the posterior metatarsus is biseriately spined beneath, the pulvillus is not quite apical but extends a short distance upwards, and the whole segment, though long, is not longer than the other segments combined. This species is typical of a group lying between *Platyzosteria* and those undoubted examples of *Cutilia* with the long posterior metatarsus and apical pulvillus. There are several species which would fall into this group, and although time and opportunity do not permit of their being indicated in the present paper, I would venture to suggest the name *Cutiloidea* as being appropriate for an intermediate genus distinguished from *Platyzosteria* by the presence of a biseriate row of spines beneath the posterior metatarsus, and distinguished from *Cutilia* on the other hand by the fact that this row of spines is not the whole length of the segment, the distal half of which, approximately, is occupied by a backward production of the pulvillus; the genotype being *communis* Tepp. There is very little variability in the form of the supra-anal lamina of the ♀ in *Cutilia* and this, if found correlated to a special tarsal structure, may prove a useful character.

The ♂ *communis* has a gland opening on the 1st abdominal tergite, situate in the middle line, close to the anterior margin, and concealed by the metanotum. Shelford (1909) has pointed out that an allied species *semivitta* Walk. possesses a similar structure, and this species is also a *Cutilia*. In colour *communis* varies from nigro-castaneous to fuscous, and in the larva the disc of the tergites is often much paler. In them also the pale thoracic border is found all round the abdomen, and in some adults this persists in the form of lateral yellow spots on tergites 1 to 4.

There is a striking superficial resemblance between some larvae of this species, larvae of *Methana marginalis*, and the adult form of *Cutilia sedilloti* Bol., but *sedilloti* has tegminal vestiges, and paler legs; and the prolonged postero-lateral angles of the meso- and metanotum of *marginalis* (the rudiments of the flying organs) readily separate them.

Tepper's use of the word "Cotype" is indefinite; he certainly did not use it in the restricted sense of a Primary Type, nor does he mean what is usually understood by "Paratype," for I have in my collection specimens marked "Cotype" by Tepper himself, captured at localities not mentioned in the original description and on dates long subsequent. What I think he meant was specimens compared by him and agreeing with his type; but then we know that most of his Blattid types were not so designated by him until 1915, many years after he had published his descriptions.

Cutilia circumducta Walker.

Periplaneta circumducta Walk., *Cat. Blatt. Brit. Mus.*, 1868, p. 143.

Specimens taken by Dr. Mjöberg at Broome and in Kimberley district, Western Australia, and by Mr. N. B. Tindale at Groote Eylandt in the Northern Territory are perhaps this species. The vestigial tegmina are completely articulated, there are no wing vestiges, and the posterior metatarsi are of the *Cutilia* type. Larvae of this species closely resemble those of *C. communis* Tepp., but the tarsal structure of the latter is of the *Cutiloidea* type, the yellow border disappears from the abdomen either completely or partly at maturity, and the face is immaculate. Whether these specimens should be referred to Walker's *circumducta* or not, they certainly are not Tepper's *submarginata* (q.v.) which has posterior metatarsi of the *Platyzosteria* type.

Cutilia illingworthi Shaw.

Cutilia illingworthi Shaw, Proc. Linn. Soc. N.S.W. xlvii, 1922, p. 227, Text-fig. 4.

New Localities.—Victoria: Mallee district. A small ♀ (No. 347, Coll. Shaw) 18.0 mm. long, sent to me in 1920 by the late F. P. Spry, is probably this species from an unexpected locality. *Lord Howe Island*: One small ♀, Macleay Mus., Sydney.

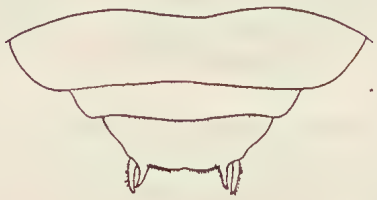
Cutilia parva Tepper.

Periplaneta parva Tepp., *Trans. Roy. Soc. S. Aust.*, 1895, p. 162.—*Platyzosteria parva* Tepp., Shelford, *Gen. Ins.*, Fasc. 109, 1910, p. 7.

The type of this species is in the South Australian Museum and agrees well with the description. The posterior metatarsus is typically that of *Cutilia* Stål, the insect is completely apterous, the pale segments of the antennae can be plainly seen, and the ootheca is not longitudinally fluted.

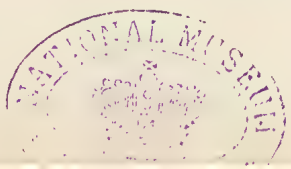
Cutilia pulchra, n. sp. Text-fig. 15.

♂. Head yellow, a broad castaneous streak extending from the vertex to the margin of the clypeus; labrum castaneous, slightly emarginate; antennae longer than the body, fuscous. Pronotum exposing the vertex, nigro-castaneous, almost black, with two broad yellow transverse bands; mesonotum and metanotum similarly coloured, but with only one yellow band; margins of all the bands



Text-fig. 15. *Cutilia pulchra* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from the holotype.

irregular; lateral margins of all the thoracic tergites narrowly castaneous; vestigial tegmina completely separated, apex obliquely truncate, coarsely punctate, with a dark macula occupying the anal portion; abdominal tergites rich rufo-castaneous, except laterally, where on tergites 2 to 7 a large yellow macula is situate, the area surrounding this macula being darker than the disc; postero-



lateral angles of tergites 5, 6 and 7 backwardly produced, lateral margins entire. Legs with the coxae sordidly greyish, all the coxal ridges with their surfaces spinose; coxal borders paler, and a dark macula occupying the upper portion of the middle and posterior coxal grooves; tibiae castaneous; tarsi testaceous, posterior metatarsus longer than the remaining tarsal segments combined, biseriately spined beneath, pulvillus apical, remaining segments unspined, with large pulvilli; ungues missing. Supra-anal lamina subquadrate, widely emarginate, fimbriate, lateral margins serrate; subgenital lamina (Text-fig. 15) subquadrate, posterior margins straight; styles lateral, castaneous, a large strong spine at the base of each, nearly as long as the style, distal half of spines yellow; cerci longer than the lamina.

Length.—19.0 mm.

Type material.—Holotype ♂, Macleay Mus., Sydney.

Habitat.—*New South Wales.*

Note.—This unique specimen, which is not included in the above key, is in the Macleay Museum, Sydney, with no other label than N.S.W.; and when fresh its rich colouring must have made it a very striking species.

Cutilia secunda Tepper.

Leptozosteria secunda Tepp., *Trans. Roy. Soc. S. Aust.*, 1894, p. 183.—*Polyzosteria triangulata* Br. v. Wattenwyl, *Ann. Mus. Civ. Genova*, Ser. 2a, xiii, 1893, p. 33; Krauss., *Denkschr. med-nat. Ges. Jena*, viii, 1903, p. 750, Pl. lxvii, fig. 1 (fide Shelf.).—*Cutilia triangulata* Shelford, *Trans. Ent. Soc. London*, 1909, p. 291.

Brunner v. Wattenwyl's few words, referring to an undescribed species, cannot be regarded as a sufficient diagnosis; but Tepper's description is good and well detailed. That Krauss gives a good description and figure under a wrong name does not make that name right. The inappropriateness of name which Shelford (1909) condemns was quite appropriate to Tepper when he placed the species as a second one in his genus *Leptozosteria;* and anyhow a consideration of this kind should not weigh in a question of priority. I think the explanation is that Shelford showed, here and there, evidence of a not unnatural irritation at what he considered to be Tepper's want of courtesy. I have examined Tepper's type of *secunda* and the posterior tarsal structure is typically that of *Cutilia.* This species sometimes occurs in houses.

New Localities.—Queensland: Laura (T. G. Sloane, 1916), Townsville (F. H. Taylor, ex house), Gordonvale and Babinda (J. F. Illingworth, 1917), Clermont (Miss B. Carne, 1920), Cairns (J. F. Illingworth, ex house). *New Guinea* and *Darnley Island* (Macleay Mus., Sydney).

Cutilia subbifasciata Tepper.

Drymaplaneta subbifasciata Tepp., *Trans. Roy. Soc. S. Aust.* xvii, 1893, p. 112.—*Platyzosteria subbifasciata* Shelf., *Trans. Ent. Soc. Lond.*, 1909, p. 286.—*Cutilia subbifasciata* Shaw, *Vict. Nat.* xxxi, 1914, p. 106.

I have examined the specimens from the Northern Territory marked by Tepper as his types. They are a larval ♂ and a larval ♀; both belong to the Genus *Cutilia* Stål, and both have the dorsal pale lateral border continued around the abdomen. This species varies in colour, and in some specimens, as in Mr. Tindale's from the Roper River, most of the pale colour is absent; it also affords another example of the occasional persistence in the adult of the pale border of the abdominal tergites usually lost at the last ecdysis. In the Macleay Museum in Sydney the

locality "N.S.W." on two old specimens must be regarded as doubtful, and a third, a larval ♂, is labelled "*Polyzosteria macleayi* Sauss., Port Darwin," a name I am unable to trace, and one not mentioned by either Shelford or Kirby.

New Localities.—Port Darwin and Melville Isd. (Baldwin Spencer, Aug., 1912. Nat. Mus. Melb.); N.S.W. (Macleay Mus.); Roper River, N. Terr. (N. B. Tindale, S. Aust. Mus.).

Genus Cosmozosteria Stål.

The species of this genus are difficult to separate as, on the whole, there is little difference in structure between them. The supra-anal lamina of the ♂ in all the species is straight and fimbriate posteriorly, with deflected spines at the postero-lateral angles, except in *C. picta* Tepp. (= *gloriosa* Shelf.) where it is slightly convex and unspined; the subgenital lamina of the ♂ is in all widely emarginate with strong divergent spines (less marked in *picta* Tepp.). All the species are castaneous, and all, with the exception of *C. froggatti* Shelf., have prominent flavid markings. The flavid markings vary much in some species, the larvae showing them more than the adults. In *C. zonata* Walk., for example, while the adult has simply 3 or 4 transverse bands, the larva may have a lateral flavid border practically all round. I had hoped to give a satisfactory key to the species, but the more I examine them the greater the uncertainty, and now I have only time to offer a few remarks about some of the species. I have examined Tepper's types and his *C. maculimarginata* is probably a distinct species, though his "Type of ♂" and "Type of ♀" are both female larvae, and in this genus it is not wise to describe new species unless from an adult. His *C. picta* is a good species and Shelford's *gloriosa*, also described from a ♀, is identical with it. His "Cotype," also an adult ♀, is not conspecific with the type, but I believe it to be identical with a species of which I have several specimens from North Queensland, and which I here describe as *C. sloanei*. Tepper's *subzonata* is also, I think, a distinct species, certainly not *bicolor* Sauss. (as Shelford thought), nor identical with the species occurring around Brisbane which I (1918) mistook for it. This last species does not appear to agree with any of the others, though nearer to *C. subzonata* Tepp., and I here describe it as *C. brisbanensis*. Another curious point about this genus is that in a very large proportion of the ♂ the subgenital lamina is found to be deformed, one postero-lateral angle (commonly the right one) being rounded instead of being produced into the usual divergent spine; or one spine may be much longer than the other. *C. froggatti* Shelf. and *C. lateralis* Walk. differ structurally from the remainder in the abdominal tergites not being scabrous, but closely covered with shallow pits.

As previously pointed out, the pale marginal colour of the larva is to a large extent lost in the adult. In *C. zonata* Walk. all the larvae in my collection show a yellow anterior pronotal border, and in several the yellow border is carried practically all round the insect. When maturity is reached, only the three bands on the posterior borders of the thoracic tergites are left, this being Walker's (1868) *trifasciata;* but sometimes the anterior pronotal band persists and his (1868) *quadrifascia* appears. Then again, in other species such as *C. sloanei* mihi, the pronotal yellow margin in the adult varies in extent, sometimes becoming obsolescent, leaving only a couple of small antero-lateral bands.

Amongst some specimens from Northwest Australia of a species near *C. zonata* Walk. are a ♂ and ♀ in the Stockholm and Sydney Museums respectively, with

the castaneous disc of the pronotum completely surrounded by a broad yellow band, the remaining specimens having a quadrifasciate form. These latter are probably the normal form of an undescribed species, and those with the complete band a variety. Several specimens of the normal form were taken by Mr. N. B. Tindale at Maria Island and the Roper River in the Gulf of Carpentaria, and one by Dr. Mjöberg at Broome in Western Australia.

Cosmozosteria brisbanensis, n. sp.

Cosmozosteria subzonata Shaw, *Mem. Q. Mus.*, 1918, p. 162.

Near *subzonata* Tepp., but is smaller, the line of demarcation between the dark disc of the thoracic tergites and their yellow posterior border is clean cut, the lateral yellow spots of the abdominal tergites are smaller, only occupying the cephalic half of the tergital width, and the postero-lateral angles of the meso- and metanotum are not so much produced caudally. The proportion of the two species as to length and width is about the same, and both are relatively broader than *bicolor* Sauss. The laminae and tarsi are of the *Cosmozosteria* type.

Length.—♂, 20.0-22.5 mm.; ♀, 22.5-27.0 mm.

Type material.—Holotype ♂, No. 0/2893; allotype ♀, No. 0/2893a; and paratypes, 32. Coll. Q. Mus.

Habitat.—*Queensland*: Brisbane, Ipswich, Rosewood, Mt. Tambourine, Christmas Creek, Jandowae, Upper Burnett district.

Cosmozosteria sloanei, n. sp.

Rich castaneous. Pronotum relatively wider than that of *C. bicolor* Sauss.; thoracic tergites with a few scattered shallow pits; abdominal tergites scabrous; angles of the 9th lobiform, yellow; supra-anal and subgenital laminae and tarsi of the *Cosmozosteria* type. A broad yellow border surrounding the front and sides of the pronotum, except at the postero-lateral angles which are castaneous; this border is continued on the meso- and metanotum as large irregular maculae, not reaching the postero-lateral angles, and similarly on abdominal tergites 2 to 7. Coxal borders narrowly yellow.

Length.—♂, 20.0-22.5 mm.; ♀, 22.5-27.9 mm.

Type material.—Holotype ♂, No. 0/2894; and allotype ♀, No. 0/2894a. Coll. Q. Mus.

Habitat.—*North Queensland*: (Holotype) Laura near Cooktown (T. G. Sloane, July, 1916); (Allotype) Kuranda; Townsville (G. F. Hill); Herbert River, ex beach; Cairns and Gordonvale (J. F. Illingworth).

Note.—This species varies considerably in the extent of the yellow margin. In the types it is an almost continuous band, though never so extensive as in *C. bicolor* Sauss., where it is quite continuous round the thoracic tergites at least; whilst in some specimens of *C. sloanei* the posterior one-third to two-thirds of the lateral borders of the thoracic tergites is castaneous, and in others the posterior end of the yellow margin turns slightly inwards upon the pronotum. Where the yellow margin of the thoracic tergites is diminished the yellow maculae on the abdominal tergites are replaced by small dots. Those specimens with less yellow are usually larger, and I may be confusing two distinct species, but I regret that the short time at my disposal compels me to leave the genus in a rather chaotic state.

Genus ANAMESIA Tepper.

ANAMESIA ORNATA Tepp.

Pseudolampra ornata Tepp., *Trans. Roy. Soc. S. Aust.*, 1892, p. 98.

There is no doubt but that this beautiful species should be placed in *Anamesia*. None of the abdominal tergites is produced, and none of the thoracic tergites has a thickened margin.

Habitat.—*S. Australia*: Murray Riv. (H. S. Cope, S. Aust. Mus.).

Note.—With regard to the non-production of the postero-lateral angles of the distal abdominal tergites in *Anamesia* Tepp. and *Desmozosteria* Shelf., this character should not be taken as absolute, but only as compared with the angles in allied genera. Even within the limits of one species such as *A. lambii* Tepp., specimens in my collection show a variation from an evident though slight production, to an entire absence of any.

ANAMESIA PUNCTATA Tepper.

Pseudolampra punctata Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 97.

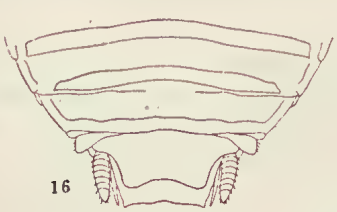
Described by Tepper from specimens obtained near the Fraser Range, Western Australia, by the Elder Expedition in 1891, and Shelford mentions it as from Tennant's Creek, South Australia. There are specimens in the South Australian Museum from other localities in South Australia, and Mjöberg in 1910-13 took it in Kimberley district, and at Derby in Northwest Australia. The species seems to vary considerably in colour, some specimens being much paler than others, and in some the punctures are almost obsolete. It is possible that *A. walkeri* Shelf. may be a very pale example.

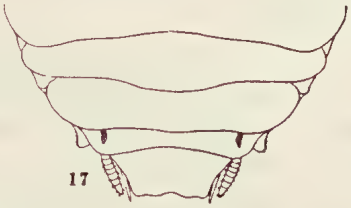
Genus DESMOZOSTERIA Shelford.

DESMOZOSTERIA CINCTA Shelf. Text-figs. 16 and 17.

Desmozosteria cincta Shelf., *Trans. Ent. Soc. Lond.*, 1909, p. 303.

Shelford described the ♀ from Central Australia, and the type is in the Senckenberg Museum. A ♂ in the Queensland Museum from Charleville in the far west of Queensland is, I believe, conspecific, and descriptive notes supplementary to Shelford's description are added.





Text-fig. 16. *Desmozosteria cincta* Shelford. ♂. Apex of abdomen, dorsal aspect. Drawn from the allotype.

Text-fig. 17. *Desmozosteria cincta* Shelford. ♂. Apex of abdomen, ventral aspect. Drawn from the allotype.

Allotype ♂. Lateral margins of the abdominal tergites also ochreous, tips of the angles of the 9th tergite ochreous; 6th abdominal sternite sinuate posteriorly; supra-anal lamina (Text-fig. 16) subquadrate, angles obtuse, widely emarginate, fimbriate, extending to about ¾ the length of the cerci, rufo-castaneous, with the posterior border widely ochreous; subgenital lamina (Text-fig. 17)

quadrate, nearly black, lateral margins concave, posteriorly widely emarginate, styles lateral. Posterior metatarsus not so long as the remaining segments combined, not spined beneath, with the pulvillus extending upwards the whole length of the segment in the form of a compressed ridge.

Type material.—Allotype ♂, No. 0/2897. Coll. Q. Mus.

Habitat.—Queensland: Charleville (L. Franzen).

DESMOZOSTERIA GROSSE-PUNCTATA Shelf (loc. cit.).

Shelford did not know the locality of his type in the Oxford Museum, but presumed it to be Australia. Basedow's specimen, however, agrees almost perfectly with Shelford's description, and his locality brings this species into line with the rest of the genus.

Habitat.—Western Australia, Dr. H. Basedow, one larval ♀, No. 40060, Aust. Mus., Sydney.

DESMOZOSTERIA ZEBRA Tepper.

Polyzosteria zebra Tepp., *Horn Exped. Cent. Aust.*, Vol. 2, 1896, p. 362.—*Platyzosteria zebra* Shelf., *Trans. Ent. Soc. Lond.*, 1909, p. 288.—*Cosmozosteria zebra* Kirby, *Syn. Cat. Orth. Brit. Mus.*, Vol i, 1904, p. 133.

Shelford was in doubt as to the generic position of this species, and, although I have seen the type, I have some uncertainty in placing it in *Desmozosteria* Shelf. Tepper's description is good as far as it goes, but the margins of all the thoracic tergites are definitely thickened, the postero-lateral angles of the 5th abdominal tergite are not produced, of the 6th scarcely, and of the 7th not much. In *D. zebra* the cerci are not short nor flattened, the spines of the tibiae are triseriately arranged on the outer aspect, and the caudal metatarsus is as long as the remaining segments combined, is unspined beneath, and bears a long pulvillus; the other segments have large pulvilli, and the supra-anal lamina is rounded, but damaged. The angulation of the caudal tergites, as a character, does not appear to be quite reliable, for in some species of *Cosmozosteria* the angles of the 5th tergite are a little produced, and those of the 6th usually more so; and in *Anamesia* and *Desmozosteria* the 7th tergite sometimes has a slight backward production.

Genus TEMNELYTRA Tepper.

This quite distinct genus includes four species, of which one is added in the present paper. In all, the posterior metatarsus is shorter than the remaining tarsal segments combined, and in two of the species, *truncata* Br. v. W. and *subtruncata* Tepp., there is a remarkable modification of the tarsal claws; the external claw being abortive and not so long as the somewhat asymmetrical arolium, to the outer side of which it appears to be attached. It is only with considerable magnification that the abortive claw can be distinguished, the tarsus appearing to terminate in a single claw and large arolium. In specimens in which only four tarsal segments are found, the first (metatarsus) and second are longer than normal, and the metatarsal pulvillus extends some distance upwards. The first abdominal tergite of the ♂ bears an organ ("gland opening") which varies in each species, but always takes the form of a symmetrical tumefaction bearing a tuft of bristles on its cephalic aspect. Shelford (1909) figures the tergite of *T. truncata*.

Key to the species of *Temnelytra*.

(4)	1. Metanotum not bearing vestigial wings, claws asymmetrical.	
(3)	2. Larger size, testaceous, abdominal tergites with lateral yellow border	*truncata* Br. v. W.
(2)	3. Smaller size, fuscous, abdominal tergites concolorous	*subtruncata* Tepp.
(1)	4. Metanotum bearing vestigial wings, claws symmetrical.	
(6)	5. Pronotum with two prominent fuscous vittae	*undulivitta* Walk.
(5)	6. Pronotum fuscous, with pale lateral borders	*tryoni* Shaw.

TEMNELYTRA TRUNCATA Brunner v. W.

Polyzosteria truncata Br. v. W., *Nouv. Syst. Blatt.*, 1865, p. 217.—*Temnelytra harpuri* Tepp., *Trans. Roy. Soc. S. Aust.*, 1893, p. 39.—*Zonioploca harpuri* Kirby, *Syn. Cat. Orth. Brit. Mus.*, Vol. i, 1904, p. 137.—*Temnelytra truncata* Shelf., *Trans. Ent. Soc. Lond.*, 1909, p. 305, Pl. ix, figs. 37a and 37b.

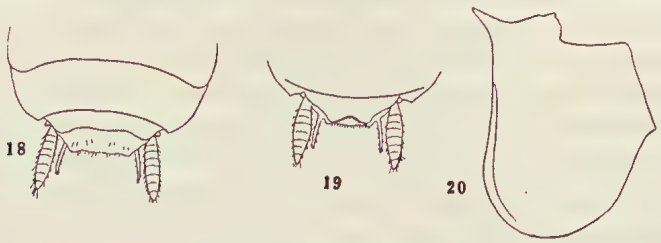
There is some question as to Tepper's types of *T. harpuri* as the specimen labelled "Type of ♂" is really a ♀, captured after the publication of his description, and although he described both sexes, there is no ♂ in the South Australian Museum. However, this species is almost certainly identical with Brunner's *T. truncata* of which he described the ♀ in 1865, and Shelford (1909) figured parts of the ♂. The tarsal claws of this species are asymmetrical, the outer claw being modified. Brunner v. Wattenwyl (1865), in addition to New South Wales, gives New Zealand as a locality for this species. This is possibly an error, Brunner not differentiating the New Zealand species *T. undulivitta* subsequently described by Walker (1868).

TEMNELYTRA SUBTRUNCATA Tepper.

The types of ♂ and ♀ are in the National Museum, Melbourne, and this is quite a distinct species. The first abdominal tergite of the ♂ bears a medial gland opening surmounted by bristles, resembling that of *truncata* Br. v. W., but quite different from that of *undulivitta* Walk. (q.v.). This species and *truncata* share several characters in common, such as the absence of wing vestiges, similarity of structure of the first abdominal tergite, and asymmetry of the tarsal claws.

TEMNELYTRA TRYONI, n. sp. Text-figs. 18 and 19.

♂. Head testaceous, with the vertex dark fuscous, and a dark longitudinal band, narrower in the middle, occupying most of the frons; antennae fuscous, hirsute. Pronotum with the disc dark fuscous laterally, bordered yellow, the extreme margin fuscous. Tegmina pale fuscous bordered yellow, extending to the posterior margin of the first abdominal tergite. Venation, except the *vena*



Text-fig. 18. *Temnelytra tryoni* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

Text-fig. 19. *Temnelytra tryoni* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from the holotype.

Text-fig. 20. *Scabina antipoda* Shelford. ♂. Left tegmen.

dividens, obscure. Wing vestiges lateral, lobiform, separated from the metanotum. Abdominal tergites fuscous with pale borders; 1st abdominal tergite with a medial, broad-based triangular tumefaction furnished cephalically with bristles; 7th tergite sinuate caudally. Supra-anal lamina (Text-fig. 18) transverse, fimbriate, widely emarginate, lateral margins slightly concave. Subgenital lamina (Text-fig. 19) transverse, caudal margin concave; styles smooth, long, not sharply pointed. Abdominal sternites fuscous. Legs testaceous; coxae with some fuscous markings; posterior metatarsus nearly as long as the remaining segments combined, biseriately spined beneath, pulvillus short, claws symmetrical.

♀. *Larva.* In general colouring similar to the adult. Postero-lateral angles of the mesonotum scarcely, and of the metanotum well produced backwardly. Subgenital lamina of the usual Blattine larval form.

Length.—20 mm. (approximately).

Type material.—Holotype ♂, No. 0/2896 (in two parts); and paratype, larval ♀, No. 0/2896a. Coll. Q. Mus.

Habitat.—*Queensland*: National Park, Lamington Plateau (3,000 ft., H. Tryon, Jan., 1917).

Note.—The holotype is rather damaged, and the apex of the abdomen is on a separate card; but the species is quite distinct and the paratype is in more perfect condition.

Temnelytra undulivitta Walker.

Periplaneta undulivitta Walk., *Cat. Blatt. Brit. Mus.*, 1868, p. 144.

This species much resembles another New Zealand one, *Cutilia sedilloti* Bol. (1882), from which its tegminal structure at once distinguishes it. In common with the new species *T. tryoni* mihi it has symmetrical tarsal claws, a fairly similar form of 1st abdominal tergite, and wing vestiges separated from the metanotum; although in the only ♂ in my collection the postero-lateral angle of the metanotum presents a well marked notch, and the wing vestige, instead of being separate, is only evidenced by a lateral curved crumpling. The subgenital lamina of the larval ♀ is of the usual Blattine form.

New Localities.—Chatham Is. (1887, J. J. Fougère, teste F. W. Hutton). *New Zealand*: Invercargill, The Hump, 3,500 ft., 1912; Longwoods, 1913; and Hunter Mts., near Green Lake (under stones, 1919, A. Philpott).

Genus Scabina Shelford.

Scabina antipoda Shelford. Text-fig. 20.

Pelmatosilpha (?) *antipoda* Kirby, *Ann. Mag. Nat. Hist.* Ser. 7, xii, 1903, p. 376.—*Scabina antipoda* Shelf., *Trans. Ent. Soc. Lond.*, 1909, p. 306.

Kirby described this species from Queensland, but neither he nor any subsequent writer appears to have noticed a strong spine which extends forwards and outwards from the antero-external angle of the quadrate tegmen (Text-fig. 20). This is present in the ♂ only, the ♀ having no trace of it. The object of this spine is to me obscure, and I can only suggest that it acts as a support to the angles of the pronotum, which is very wide, and which in the ♂ can get no support from the humeral angle of the tegmen, since in that sex the costal portion of the tegmen is deflected. This deflection is not found in the ♀, nor is the spine.

This species occurs commonly under the bark of trees in the Rain Forest areas of South Queensland, at an elevation of about 2,000 ft.

Genus METHANA Stål.

Shelford (1909) includes eight species in this genus; Hanitsch (1915) added *semimarginalis* from Borneo, and to these, three are added in the present paper, making twelve in all, including *pallipalpis* Serv. of which the type is lost and the position uncertain. Of two of these species, *semimarginalis* Hanitsch and *hosei* Shelford, only the ♀ is known; but in the remaining nine (excluding *pallipalpis* Serv.) the supra-anal lamina of the ♂ does not show any great variation in form. It is usually subquadrate, fimbriate, and with some emargination; in *curvigera* Walk. it is medially carinate, in *marginalis* Sauss. it is entire or has a small medially-situate backward production, in *sjöstedti* mihi it has a deep angular emargination, and in *convexa* Walk. it is almost bilobate. The subgenital lamina of ♂ is subquadrate and its posterior margin may have a wide, shallow, rounded emargination as in *marginalis* Sauss., *soror* Sauss. and *mjöbergi* mihi; may be bilobate as in *sjöstedti* mihi; deeply and angularly emarginate with divergent postero-lateral angles (resembling *Cosmozosteria*) as in *curvigera* Walk. and *parva* mihi; or with blunt projections at the base of the styles as in *convexa* Walk. In all the species known to me the styles are long, slender, slightly tapering, and not very sharply pointed, with the exception of *sjöstedti* mihi whose styles are very different from those of the other species, being broad, flattened and acuminate, somewhat resembling a Malay "kris."

Ootheca. In the Queensland Museum there is a ♀ *M. marginalis* Sauss. with an attached ootheca carried suture downwards, and this is the only ootheca of the genus I have seen. I cannot say whether this position is usual, but the position of the ootheca, as a character, is not quite reliable, a ♀ *Blattella germanica* L. in my collection, for instance, carrying it uppermost, although the lateral position is given as a generic character.

In the key to the species below, the form of the laminae has not been used, as this is not constant enough, and relates to the one sex only. The presence or absence of a flavid humeral streak, the colour and markings of the pronotum, and particularly the dark markings of the vertex and frons afford valuable characters, and apply to both sexes.

Key to the species of *Methana*.

(4)	1. Uniform castaneous.	
(3)	2. Larger size, over 30 mm.	*magna* Shelf.
(2)	3. Smaller size, under 30 mm.	*convexa* Walk.
(1)	4. Not uniform castaneous.	
(6)	5. Pronotum testaceous, with fuscous vittae	*curvigera* Walk.
(5)	6. Pronotum castaneous, with flavid margins.	
(14)	7. Pronotum not bordered flavid posteriorly.	
(13)	8. Castaneous disc of the pronotum immaculate.	
(10)	9. Tegmina without a flavid humeral streak	*semimarginalis* Hanitsch.
(9)	10. Tegmina with a flavid humeral streak.	
(12)	11. Flavid humeral streak longer than the anal area, dark band of the vertex not continuous with that of the frons	*marginalis* Sauss.
(11)	12. Flavid humeral streak not longer than the anal area, dark band of the vertex continuous with that of the frons	*parva* Shaw.
(8)	13. Castaneous disc of the pronotum with two flavid maculae	*soror* Sauss.
(7)	14. Pronotum bordered flavid posteriorly.	
(16)	15. Tegmina uniformly castaneous	*hosei* Shelf.
(15)	16. Tegmina with a flavid humeral streak.	

(18) 17. Vertex black ..... *mjöbergi* Shaw.
(17) 18. Vertex testaceous.
(20) 19. Frons immaculate ..... *sjöstedti* Shaw.
(19) 20. Frons with a broad castaneous band ..... *papua* Shelf.
Species incertae sedis ..... *pallipalpis* Serv.

METHANA CONVEXA Walker.

Periplaneta convexa Walk., *Cat. Derm. Salt. Brit. Mus.*, Suppl. Blatt., 1869, p. 152.—*Methana convexa* Kirby, *Syn. Cat. Orth. Brit. Mus.*, Vol. i, 1904, p. 136.—*Methana rufescens* Kirby, *Ann. Mag. Nat. Hist.* (7) xii, 1903, p. 374 (teste Shelford).—*Paraphoraspis* (?) *castanea* Tepp., *Trans. Roy. Soc. S. Aust.*, 1894, p. 173.

This species is distributed over a long range on the eastern side of Australia from Victoria to North Queensland, and occurs not only near sea level, but at high elevations such as Uralla, N.S.W., 3,500 ft. (W. W. Froggatt) and Tambourine Mountain, 2,000 ft. (auct.).

Tepper's type of *Paraphoraspis* (?) *castanea* is in the South Australian Museum, and is a ♀ of this species, and came from the most southerly recorded locality, Howbulan, Victoria.

METHANA PARVA, n. sp. Text-fig. 21.

Closely resembling *M. marginalis* Sauss., but differing from it in the following points: (1) Size much smaller than *marginalis* Sauss.; (2) flavid humeral streak not extending beyond the anal area; (3) subgenital lamina of the ♂ longer, deeply emarginate; (4) castaneous band of the frons joining that of the vertex; (5) tegmina not extending beyond the body.

The flavid humeral streak is in this species confined to the costal area, not extending, as in *marginalis* Sauss., to the tips of the 1st or 2nd branches of the radius; and in *marginalis* Sauss. the costal area is longer than the anal area. The subgenital lamina of the ♂ is in *marginalis* Sauss. transverse with a straight posterior margin, whilst that of this species (Text-fig. 21) is prolonged backwards, deeply and widely emarginate, and ends in divergent points. In all my ♂ specimens, one of these points is longer than the other, but this appears to be a deformity, the lamina of a larval ♂ being symmetrical. This shortening of one of the postero-lateral angles of the subgenital lamina commonly occurs in the ♂ of the genus *Cosmozosteria* Stål. In this species the dark band of the frons is always joined to the dark vertex; in *marginalis* Sauss. this is never so, and a large number of specimens have been examined. This character also serves to separate the larvae. The anal veins all terminate on the *vena dividens*, none of them reaching the margin of the tegmen. This character is common to all the species of *Methana* in my collection.

Length.—♂, 20.0-21.0 mm.; ♀, 20.0-22.0 mm.

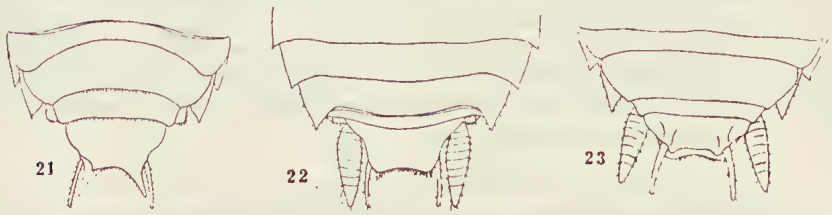
Type material.—Holotype ♂; No. 0/2873; allotype ♀, No. 0/2873a; 8 paratypes. Coll. Q. Mus.

Habitat.—*Queensland*: Green Is., Moreton Bay; Tambourine Mt., 2,000 ft. (auct.); National Park, Lamington Plateau, 3,000 ft. (H. Hacker).

Note.—The species which I take to be Saussure's *marginalis* is considerably larger than this, averaging 28 or 29 mm. in length, and is common in the Brisbane district. Saussure's description gives 29 mm. as the length of the ♀, and as the two are evidently not conspecific, I am regarding the smaller species as the new one. It is a curious fact, however, that, when in 1914, Prof. E. B. Poulton kindly brought me some duplicates from the Hope Museum, the single specimen labelled

Methana marginalis Sauss. agreed entirely with my *parva*, and it seems probable that the two species are mixed up in the older collections. Saussure's type is in the Paris Museum.

Variety HACKERI (with abbreviated tegmina).—In the Queensland Museum there is a ♀ (No. 0/2904) taken in Dec., 1921, by Mr. H. Hacker at the Queensland National Park, in which the tegmina are truncate, not extending beyond the 2nd abdominal tergite, and the wings are lobiform. The anal is shorter than the costal area.



Text-fig. 21. *Methana parva* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from the holotype.
Text-fig. 22. *Methana mjöbergi* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from paratype No. 0/2874. Coll. Q. Mus.
Text-fig. 23. *Methana mjöbergi* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from paratype No. 0/2874. Coll. Q. Mus.

METHANA MJÖBERGI, n. sp. Text-figs. 22 and 23.

Vertex testaceous, frons occupied by a broad, dark, castaneous streak with irregular edges, and broadening below into a curved, transverse marking; antennae fuscous, labrum bilobate. Pronotum with wide, flavid, anterior and lateral margins, widest at the postero-lateral angles, posterior margin narrowly flavid, disc dark castaneous, paler centrally, and extending in a small medial angular projection towards the vertex. Tegmina castaneous, about the length of the body, with a flavid humeral streak. Legs testaceous, spines brown, tibiae of the ♂ brownish. Posterior tarsi typically *Methana*. Arolia large. Abdomen fusco-castaneous, lateral margins of the tergites paler. Supra-anal lamina (Text-fig. 22) of the ♂ quadrate, fimbriate, apex widely and slightly concave; of the ♀ more produced and more deeply emarginate. Subgenital lamina (Text-fig. 23) of the ♂ subquadrate, widely and roundly emarginate; styles long, round, slender.

Length.—♂, 20.0-22.0 mm.; ♀, 20.0 mm.

Type material.—Holotype ♂ and allotype ♀, Stockholm Mus.; two paratypes. No. 0/2874. Coll. Q. Mus.

Habitat.—*N. Queensland*: Malanda (2,400 ft.); Cedar Creek (E. Mjöberg, 1910-13).

METHANA SJÖSTEDTI, n. sp.

Head testaceous, immaculate; antennae pale fuscous; labrum bilobate. Pronotum with a broad flavid margin all round, narrowly edged with fuscous, widest at the postero-lateral angles, disc occupied by a bilobate castaneous macula. Tegmina castaneous, shorter than the body, with a flavid humeral streak extending to more than half their length. Legs dark testaceous, spines brown, tibiae of the ♂ darker, except at their upper and outer aspect; posterior tarsi typical of the genus, arolia large. Abdomen dark castaneous above and below. Supra-anal lamina of the ♂ quadrate, deeply and angularly emarginate, angles sharp;

of the ♀ produced, widely and roundly emarginate; subgenital lamina of the ♂ subquadrate, with a shallow emargination and rounded angles, being almost bilobate; styles long, wide, flattened, acuminate.

Length.—♂, 25.0 mm.; ♀, 25.5 mm.

Type material.—Holotype ♂ and allotype ♀, Stockholm Mus.;. 2 paratypes ♂, Queensland Mus., No. 0/2899.

Habitat.—*N. Queensland*: Atherton (2,466 ft., E. Mjöberg 1910-13), Stockholm Mus.; Kuranda (F. P. Dodd and J. F. Illingworth), Queensland Mus.

Note.—This species is near *soror* Sauss. and *mjöbergi* mihi; the flavid humeral streak is intermediate in length between the two, the flattened styles and shorter tegmina distinguish it from either, and the vertex and frons are immaculate, whilst *soror* Sauss. has a dark macula on the vertex, and *mjöbergi* mihi one on the frons. *M. parva* mihi is smaller, the flavid humeral streak is very short, and both vertex and frons are maculate.

Genus Tryonicus nov.

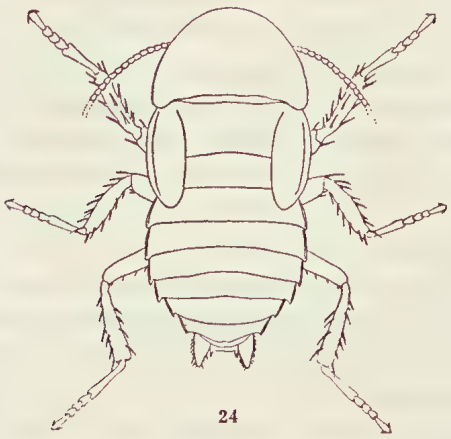
Distance between the eyes on the vertex considerably greater than that between the antennary sockets. Posterior tibiae triseriately spined on their outer aspect. Posterior metatarsi at least as long as the remaining segments combined, biseriately spined beneath; remaining segments spined beneath; all the posterior tarsal pulvilli small, apical; arolia absent. Tegmina of the ♂ vestigial, lanceolate, extending beyond the metanotum; wings vestigial, lateral, membraneous, folded; ♀ entirely apterous.

Note.—It would appear that a new genus is required for the reception of the curious cockroach described below, with its wide apart eyes, long lanceolate tegminal vestiges, spined tarsi and absence of arolia. It should perhaps come into the *Blatta* group of the Blattinae, but, as it cannot be placed in any of the existing genera, I propose to erect for it the new genus *Tryonicus*, named after its discoverer, Mr. H. Tryon, the distinguished Government Entomologist of Queensland.

Tryonicus montanus, n. sp. Text-figs. 24, 25 and 26.

Black, shining. Vertex and frons black, mouth parts brownish; antennae not so long as the body, hirsute, proximal segments cylindrical, and distal segments pyriform; eyes wider apart on the vertex than the antennary sockets (Text-fig. 25). Pronotum parabolic, truncate anteriorly, exposing the vertex, posterior margin slightly concave, lateral margins narrowly thickened and everted, as are also the lateral margins of the meso- and metanotum, and of the abdominal tergites. Vestigial tegmina of the ♂ long, narrow, completely separated from the mesonotum (Text-fig. 24), thickened margin extending to the apex, in length extending about half-way across the second abdominal tergite; wing vestiges small, lateral, membraneous, testaceous, well separated from the metanotum, with the anal portion once folded longitudinally underneath the anterior portion, not folded again, but projecting beyond the outer third of the costal margin; ♀ completely apterous. Postero-lateral angles of the abdominal tergites backwardly produced, apices blunt; posterior margin of the 7th abdominal tergite sinuate. Supra-anal lamina of the ♂ trigonal, apex truncate, lateral margins slightly thickened and everted, caudal margin pale, sparsely fimbriate, extending to about half the length of the broad-based cerci, which on the dorsal aspect are flattened, with well defined edges, and on the ventral aspect are convex, rough, and densely hirsute; of the ♀ trigonal, extending to more than three-fourths the length of the cerci (Text-

fig. 26). Subgenital lamina of the ♂ triangular, styles issuing from well defined notches, the lamina and the styles being sparsely furnished with long hairs; of the ♀, of the usual Blattine form, but sharply compressed towards the apex. Disc of the abdominal sternites castaneous. Legs dark castaneous, trochanters and tarsi paler, posterior tibiae of the ♂ with a constriction below the knee, and



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Text-fig. 24. *Tryonicus montanus* Shaw. ♂. Whole insect (× 4). Drawn from the holotype.

Text-fig. 25. *Tryonicus montanus* Shaw. Vertex of head, showing eyes and antennae.

Text-fig. 26. *Tryonicus montanus* Shaw. ♀. Apex of abdomen, dorsal aspect. Drawn from the allotype.

the segment somewhat dilated distally; those of the ♀ cylindrical. Inner aspect of the tibiae furnished with a long brush; all the tarsal segments spined beneath, hirsute, and with small pulvilli; posterior metatarsus of the ♂ longer, and of the ♀ about as long as the remaining segments combined; arolia absent.

Length.—♂, 11.0-12.0 mm.; ♀, 13.0-16.0 mm.; of tegminal vestiges 3.5 mm.

Type material.—Holotype ♂, No. 0/2872; allotype ♀, No. 0/2872a and 8 paratypes, 2 ♂ and 6 ♀, Coll. Q. Mus.; 1 paratype ♂, Aust. Mus., No. K47293.

Habitat.—*Queensland*: Lamington Plateau, National Park (3,000 ft. H. Tryon, 1917-18; A. J. Turner, 1921). *New South Wales*: Dorrigo (3,500 ft. A. Musgrave, Dec., 1922).

Genus Stylopyga Fischer von Waldheim.

Stylopyga shelfordi, n. sp.

Black, nitid, entirely apterous. Head with the margin of the clypeus, the labrum, and palpi rufo-fuscous; also the antennae, except the proximal and one or two following segments which are darker. Dorsal surface furnished with hairs set in shallow pits, denser caudally; lateral margins of all the tergites, and posterior margins of the distal tergites with a thin fringe of stiff hairs. Posterior margin of the 6th tergite sinuate; supra-anal lamina of the ♂ subtriangular, apex emarginate, cerci long and flattened; subgenital lamina of the ♂ transverse, setose, posterior margin straight; styles small, slender; a broad fuscous streak on either side of the subgenital lamina. Legs rufo-fuscous; posterior tibiae darker, and somewhat dilated in the ♂; coxal ridges punctate.

coxal borders narrowly pale brownish-yellow; posterior metatarsus long, biseriately spined for its whole length beneath, pulvillus apical; second tarsal segment also spined beneath, arolia moderate in size.

Ootheca short, deep, smooth, with eight divisions on each side.

Length.—♂, 16-17 mm. ♀, 19-20 mm.

Type material.—Holotype ♂, No. 0/2870; and allotype ♀, No. 0/2870a; and several paratypes, Coll. Q. Mus. Paratype with ootheca attached, Coll. Stockholm Mus.

Habitat.—*S. Queensland*: Samford, Capalaba, Green Is., Tambourine Mt. (auct.), Christmas Creek (E. Mjöberg). *N. Queensland*: Malanda (E. Mjöberg).

Note.—This species has been known to me for several years from various localities in South Queensland, and I welcome the opportunity of paying a tribute to Shelford's memory by naming it after him.

Stylopyga papuae, n. sp.

Closely allied to *shelfordi* mihi, but is castaneous rather than piceous, the antennae are darker, the coxae are yellowish-brown darkening proximally, the coxal borders are broadly yellow, the tibiae of the ♂ are not dilated, and the pronotum is relatively wider.

Length.—♂, 17.0 mm.; ♀, 18.0 mm.

Type material.—Holotype ♂, No. 0/2871; allotype ♀, No. 0/2871a; and paratype ♂, No. 0/2871b, Coll. Q. Mus.

Habitat.—*S. E. Papua*: Kui-ara (on the coast; auct. 1914-15).

Stylopyga immunda Shelford.

Shelford described this species as from Queensland, and says the type is in the Stockholm Museum. My collection contains specimens from the northern part of that State, and amongst the Mjöberg material collected in 1910-13 are others from the same area. *S. immunda* appears to vary considerably in size, and the colour is nigro-castaneous rather than "piceous." A large proportion of cockroaches described as black are seen to be really dark castaneous when examined in a good light and under magnification.

To Shelford's description may be added: Pronotum subtruncate anteriorly, exposing the vertex; no wing vestiges, but postero-lateral angles of the metanotum slightly produced. Sixth and seventh tergites with sparse hairs. Coxal ridges (Shaw, 1922) punctate; posterior metatarsi long, biseriately spined beneath.

Ootheca large, smooth, deep, with about 8 divisions on each side.

Length.—♂, 21.0 mm.; ♀, 22.5-26.0 mm.

Habitat.—*N. Queensland*: Cooktown (T. G. Sloane); Malanda and Bellenden Ker (E. Mjöberg); Cairns "ex log, ex bark" (J. F. Illingworth).

Genus Periplaneta Burmeister.

Periplaneta americana Linné.

This cosmopolitan species is widely spread in Australia, and I also have it from New Guinea, New Hebrides, and Lord Howe and Norfolk Islands. Its habits appear to vary somewhat. In New Guinea I found it common in houses, but *australasiae* Fabr. was much commoner in ships; whilst in Australia the latter is the common species breeding about dwellings, and, although *americana* L. is frequently found in houses, it usually flies in from outside and one does not see its larvae about. When both species live together in the same place, *australasiae*

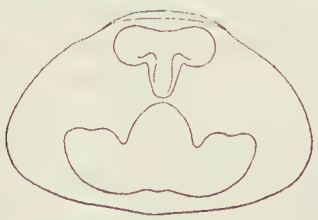
Fabr. will probably be found gradually to displace *americana* L., just as when *Supella supellectilium* Serv. invades places already occupied by *Blattella germanica* L., it tends to oust the latter. That *P. americana* L. can harbour the vibrios of Asiatic cholera has been demonstrated by M. A. Barber (1913).

PERIPLANETA AUSTRALASIAE Fabricius.

Shelford ("*A Naturalist in Borneo*," 1916, p. 115) states that *australasiae* as a specific name refers to Australia, whence the older naturalists thought it came; and, on the following page, that the species is only a rare immigrant to Australia. Whatever may have been the case when Shelford wrote, this cockroach is now well established in Australia, and, as to the name, I think Shelford must have been in error in supposing that Fabricius can have used it in any sense other than "of Southern Asia." The word Australasia as applied to Australia and New Zealand was not in use in 1775 when Fabricius described the species, nor was it commonly so until about 60 years later. Burmeister (1838) queried Fabricius's locality, and thought the species American, also stating that Fabricius's records were not infrequently unreliable. In Australia this species is quite common about dwellings, and together with the following new species usually conceals its ootheca by covering it over with mud or some convenient loose debris, and I have seen them numerously placed in chinks of a rough outhouse door, and so covered as to be difficult to discern. The ootheca is frequently attacked by one of the Chalcididae, *Geniocerus* (*Tetrastichus*) *hagenowi* Ratz., and about fifty individuals may emerge from one ootheca. Unlike *americana* L., the larvae of *australasiae* Fabr. may be found in all instars in dwelling houses, but I have never seen one which would agree with Shelford's (1911) figure of Specimen I.13767 from the British Museum collection of Blattidae, although a large number were examined with this in view.

PERIPLANETA IGNOTA, n. sp. Text-figs. 27 and 28.

This cockroach has been known to me for some considerable time, having occurred in my own house together with the two preceding species, but it was not



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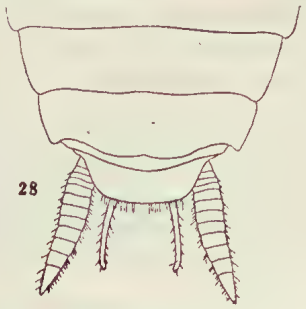

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Text-fig. 27. *Periplaneta ignota* Shaw. Pronotum showing outline of the pale macula.

Text-fig. 28. *Periplaneta ignota* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

recognized as separate until a good series was obtained from the caretaker's isolated room, perched at the end of a jetty at Wynnum, to the south of the mouth of the Brisbane River. Since then I have seen it in other collections from localities in Queensland, but it is not to be found in the older collections of the Australian Museum, Sydney, or the Macleay Museum.

The following table gives the differences between the three species:

	P. australasiae Fabr.	*P. americana* Linné.	*P. ignota* Shaw.
Yellow humeral streak of tegmen	present.	absent.	absent.
Pale marking like an inverted mushroom on dark pronotum	absent.	absent.	present.
1st abdl. tergite ♂	ample, with gland opening.	narrow, with no gland opening.	ample, with gland opening.
7th abdl. tergite ♂	sinuate, angles backwardly produced.	subsinuate, angles not backwardly produced.	sinuate, angles backwardly produced.
Supra-anal lamina ♂	short, lateral margins concave, wide, shallow emargination, or with posterior margin straight.	produced, membraneous distally, lateral margins convex, deep acute angular emargination.	short, rounded posteriorly, no emargination.
Supra-anal lamina ♀	emargination right angled.	emargination acute angled.	emargination right angled.

This table shows that *ignota* mihi is nearer to *australasiae* Fabr., but beyond the pale pronotal marking which is sometimes obscure, it can readily be separated from that species by the absence of the yellow humeral streak, and by the different form of the supra-anal lamina (Text-fig. 28) of the ♂; and this lamina is quite distinct in *americana* L. from that of either of the other two species; besides which, the postero-lateral angles of the abdominal tergites are not backwardly produced in *americana* L. The two portions of the pale pronotal marking, as shown in Text-fig. 27, are usually joined together into one macula.

Length.—♂ and ♀, 25.0-30.0 mm. Tegmina ♂, 24.0-28.0 mm.; ♀, 23.0-25.0 mm.

Type material.—Holotype ♂, No. 0/2868, and allotype ♀, No. 0/2868a, Coll. Q. Mus. Several paratypes, Colls. auct., Q. Mus., Stockholm Mus.

Habitat.—*Queensland*: Wynnum, Cleveland, Cannon Hill, Goodna (auct.), Brisbane distr. (J. C. Bridwell, H. Hacker), Noosa (W. R. Colledge), Burdekin distr. (L. Kelly), Toogoolowah (R. L. Higgins), Colosseum (E. Mjöberg).

Genus Dorylaea Stål.

Dorylaea flavicincta de Haan.

New locality.—Panaeati Is., Louisiade Archipelago. (Revd. F. J. Barnes, 1915. Coll. auct.).

Dorylaea flavifrons, n. sp. Text-figs. 29 and 30.

Uniformly castaneous dorsally. Antennae dark fuscous; vertex and frons castaneous, frons occupied by three orange-yellow maculae arranged in a triangle with its base towards the mouth, and an orange-yellow line separating the castaneous vertex from the eyes and antennary fossae; margin of the clypeus

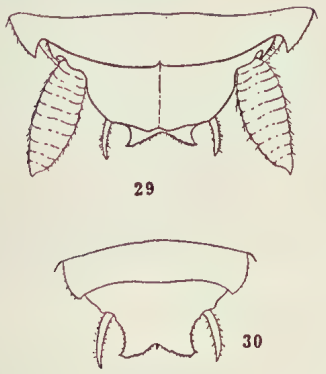
and labrum rufous, maxillary palpi pale. Tegmina semi-corneous extending to the 3rd abdominal tergite, venation obscure, anal vein terminating at the junction of the middle and outer thirds of the sutural margin. Posterior margin of the 7th abdominal tergite sinuate. Supra-anal lamina (Text-fig. 29) of the ♂ rounded, faintly emarginate, with a median longitudinal carina, extending to about half the length of the cerci; of the ♀ longer and more deeply emarginate. Subgenital lamina (Text-fig. 30) of the ♂ produced, widely emarginate, terminating in divergent points. Styles long, slightly incurved, a little longer than the lamina. Coxae pale, with large dark maculae, remainder of the legs castaneous, strongly spined; posterior tibiae, on the outer side, triseriately spined; posterior metatarsus long, biseriately spined beneath, 2nd segment spined beneath, 3rd and 4th segments unspined, pulvilli, 1st and 2nd apical, 3rd and 4th large. Genicular spines 0, 1, 1. Arolia large.

Length.—♂, 26.0 mm.; ♀, 25.0 mm.

Type material.—Holotype ♂, and allotype ♀, New Ireland, Coll. Macleay Mus., Sydney. Paratypes 3, Coll. auct.

Habitat.—*New Ireland* (Types); *New Hebrides* (W. W. Froggatt); ? *New Zealand* (A. Philpott).

Note.—The record from New Zealand is probably one of an introduced species, reaching that country in imported fruit (vide Shaw, 1922, p. 230).



Text-fig. 29. *Dorylaea flavifrons* Shaw. ♂. Apex of abdomen, dorsal aspect. Drawn from the holotype.

Text-fig. 30. *Dorylaea flavifrons* Shaw. ♂. Apex of abdomen, ventral aspect. Drawn from the holotype.

Text-fig. 31. *Ancaudellia serratissima* Brunner v. Wattenwyl. Apex of abdomen, Drawn from a specimen in the Macleay Museum.

Subfamily Panchlorinae.

Genus Oniscosoma Brunner v. Wattenwyl.

Oniscosoma minima, n. sp.

♂ fully winged. Head nearly black, mouth parts testaceous, a yellow longitudinal streak on the vertex; antennae with the sockets pale, 1st segment large and brown proximally, the two or three succeeding segments testaceous, and the remainder brown, with, in the larva, a couple of white segments towards the apex. Pronotum bearing numerous coarse tubercles, nearly semicircular anteriorly, concealing the head, convex posteriorly; a fine median longitudinal line is visible, and the widest part of the pronotum is about two-thirds along this

line from the anterior margin; anterior half testaceous with some brown markings, posterior half occupied by a fusco-castaneous macula with irregular edges and diverticula, a few fuscous spots around the margin. Tegmina hyaline with brown mottling, chiefly along the veins, but sometimes on the membrane between them. Supra-anal lamina triangular, rounded at the apex; cerci broad, blunt, somewhat incurved; subgenital lamina large, extending well beyond the supra-anal, testaceous, with a large dark macula occupying the disc, the lateral margin on the right side being more deeply emarginate; two slender acuminate styles. Abdominal sternites testaceous, with some opaque white markings laterally; stigmata well marked, fuscous. Legs testaceous. Larvae darker generally than the adult, with numerous fuscous markings, dots and tubercles.

Length.—14.0 mm.; tegmen 11.0 mm.; body 9.0 mm.

Type material.—Holotype ♂, No. 0/2867, Coll. Q. Mus.; paratypes, 2 larvae.

Habitat.—*Qucensland*: Bunya Mts. (H. Tryon, Oct., 1919).

Subfamily Panesthiinae.

Genus Panesthia Serville.

Some years ago it was suggested by me (1914) that species of the genus *Panesthia* bit off their flying organs for one another, and recently Mr. A. M. Lea, of Adelaide, told me he had observed this taking place. The reason for this is apparently to enable the insect to move more readily backwards and forwards amongst the loose soil or dessicated wood in which it lives. The two common Australian species are *australis* Br. v. W. and *laevicollis* Sauss. (unless indeed I am mixing up the latter with *cribrata* Sauss.); *australis* Br. v. W. occurs in Victoria and New South Wales, *laevicollis* Sauss. in Queensland and the north part of New South Wales, where, in the New England district, the two species overlap. Both species appear to live in families, and one usually finds associated together a pair of adults and from about 12 to 20 larvae in different ecdyses, from the penultimate down to quite early ones, and it is only where the insects are very abundant that one loses sight of this familial habit. Probably both species are viviparous.

Genus Ancaudellia, nov. Text-fig. 31.

Mr. A. N. Caudell (1924) suggests the need for removing *Panesthia serratissima* Br. v. W. to another genus on account of the structure of the postero-lateral angles of the 7th abdominal tergite. With this I quite agree, and, as I have before me several specimens of ♂, ♀, and larva from various localities, I would propose *Ancaudellia* as the name of a new genus, of which the type would be *serratissima* Br. v. W. It differs from *Panesthia* Serville as follows, and the table given below may be of some use in separating the genus from its immediate neighbours: Lateral margin of the 7th abdominal tergite deeply notched anterior to the postero-lateral angle which is somewhat laterally divergent, though produced backwards at the apex (Text-fig. 31).

(4)	1. Sixth abdominal tergite with the postero-lateral angles not, or but slightly produced.	
(3)	2. Seventh abdominal tergite with the lateral margin gently sinuate	*Panesthia* Serville.
(2)	3. Seventh abdominal tergite with the lateral margin deeply notched anterior to the postero-lateral angle	*Ancaudellia* Shaw.
(1)	4. Sixth abdominal tergite with the postero-lateral angles backwardly produced	*Miopanesthia* Saussure.

ANCAUDELLIA SERRATISSIMA Brunner v. Wattenwyl. Text-fig. 31.

Panesthia serratissima Br. v. W., *Nouv. Syst. Blatt.*, 1865, p. 394.

Brunner described this species from Ternate. He states that the larvae are completely black, but this is not so, as I have taken them in Papua of the brownish-yellow colour usual to Panesthiine larvae shortly after an ecdysis, and the young larva shows plainly the distinctive character of the genus. The ♂ varies in the depth of the excavated portion of the anterior pronotal margin, and in the prominence of the tubercles bordering it; it also bears on the vertex Saussure's (1895) "dépression en fossette."

New Localities.—S.E. Papua: Kui-ara (Coll. auct.). *New Guinea*: Katow; *Woodlark Is.* and *New Ireland* (Macleay Mus., Sydney).

Genus PLANA Brunner v. Wattenwyl.

Key to the species of *Plana*.

(4) 1. Supra-anal lamina entire.
(3) 2. Larger, more densely punctate, pronotum more transverse, subgenital lamina ♂ less visible ..... *dilatata* Sauss.
(2) 3. Smaller, smoother, pronotum less transverse, subgenital lamina ♂ more visible ..... *robusta* Tepper.
(1) 4. Supra-anal lamina crenulate ..... *crenulata* Shaw.

PLANA DILATATA Sauss.

This species and *P. robusta* Tepp. may have been confused by Tepper himself, but Saussure's (1895) notes (*Rev. Suisse Zool.*) help to clear the matter up. It is a question whether Tepper's *robusta* is not Saussure's *dilatata*, and the smaller and smoother species with the more visible subgenital lamina which Saussure calls *robusta* Tepp., and which I have separated as such, may never have been known by Tepper, and should really be Saussure's species also. Saussure (1895) says of *robusta* Tepp. "Mus. Genavense, specimina typica Tepperi." Tepper's types ♂ and ♀ in the South Australian Museum are both ♂, and were not indicated by him as his types until 22 years after he had described the species. Until a more critical examination is made of all the material in the South Australian Museum, it is better to leave the matter open.

Var. MAJOR Sauss.—The ♂ is easy to distinguish by the pronotal structure, but the ♀ difficult.

PLANA CRENULATA, n. sp. Text-fig. 32.

Large. General colour nigro-castaneous dorsally, rufo-castaneous ventrally. Head smooth, nigro-castaneous, covered by the pronotum; margin of the clypeus tawny; antennae of ♂ (♀ damaged) castaneous, 1st segment longer than the two succeeding segments. Pronotum (Text-fig. 32) nearly semicircular, postero-lateral angles rounded, and posterior margin convex; behind the anterior margin in both sexes is a tumefaction forming two prominent tubercles in the ♂, but only slightly raised and rounded in the ♀, further caudally is a depression succeeded by ridges meeting in the middle line, rough and broken up in the ♂, but smooth in the ♀, and bounded by two deep sulci converging caudally; the posterior half of the pronotum is smooth in the ♀, but occupied by a large median diverticulum extending to within 2 mm. of the posterior margin in the ♂. Mesonotum and metanotum smooth, rufo-castaneous in the disc, with the postero-lateral angles somewhat backwardly produced. Abdominal tergites 1 to 5 smooth in the disc, the outer ¼ on each side being sparsely but coarsely punctate; 6th tergite punctate along the caudal margin; 7th tergite and supra-

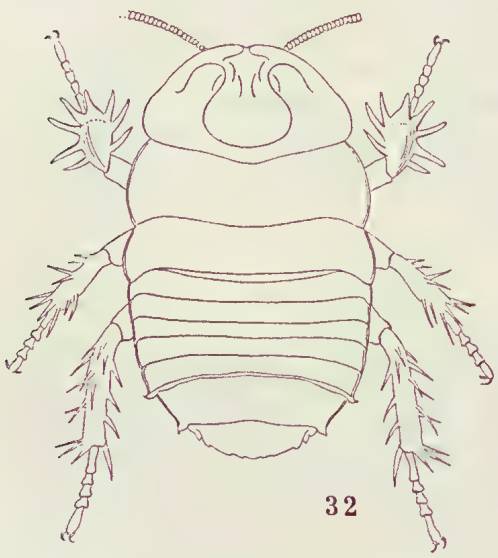
anal lamina densely and coarsely punctate; the postero-lateral angles of tergites 2 to 7 backwardly produced, that of the 6th being produced into a strong prominent recurved spine, and that of the 7th tergite being divergent and but slightly recurved; the outer portion of the caudal margin of tergites 4, 5, and 6 is thickened, and crenulate, and the plane of tergite 7 is bent at a considerable angle to that of the tergites anterior to it. Supra-anal lamina transverse, caudal margin rounded, crenulate. Abdominal sternites with the disc smooth, rufo-castaneous, margins punctate and darker. Legs rufo-castaneous, tibiae darker, anterior tibiae fossorial, anterior femora bispinose. The holotype has a group of three spines—one of them small—on the right anterior femur; the coxal process (Shaw, 1922) appears to be completely separated from the coxa, as in all the Panesthiinae.

Length.—♂, 50.0 mm.; ♀ 45.5 mm.

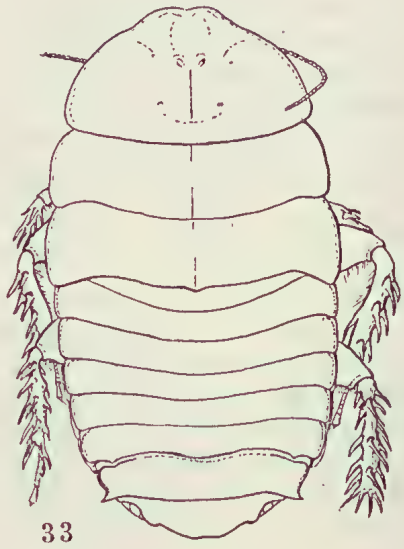
Type material.—Holotype ♂, No. 0/2861; and allotype ♀, No. 0/2861a, Coll. Q. Mus.

Habitat.—Queensland: Noosa Head (H. A. Longman, R. L. Higgins).

Note.—This fine species I at first mistook for *P. gigantea* Tepp. (q.v.), but an examination of his types undeceived me. The peculiar structure of the caudal margins of the distal tergites is of a like character, but more marked in *Macropanesthia gigantea* Tepp. (= *M. muelleri* Sauss.) and under that species an attempt is made to explain it. In addition to my types, I know of only a single ♂ in the Queensland Museum.



32



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Text-fig. 32. *Plana crenulata* Shaw. ♂. Outline of whole insect (nat. size). Drawn from the holotype.

Text-fig. 33. *Macropanesthia hirsuta* Shaw. ♂. Outline (× 3/2). Drawn from the holotype.

Genus Hemipanesthia Saussure.

Hemipanesthia Sauss., Revision des Panesthiens, *Rev. Suisse Zool.* iii, 2, 1895, p. 327.

HEMIPANESTHIA KRAUSSIANA Saussure.

H. kraussiana Sauss., loc. cit., p. 328, Pl. ix, fig. 6.—*Panesthia kraussiana* Sauss., *Mem. Soc. Sc. Phys. Nat. Genève*, xxiii, 1872, p. 150.

Saussure described this species from the neighbourhood of Melbourne, and the type is in the Geneva Museum. The Macleay Museum collection contains 1 ♂, 1 ♀ (Rockhampton) and 2 larval ♀ (N. S. Wales). Of these the ♂ measures 32 mm., the ♀ 37 mm., and the larvae 24 mm., and 26 mm. in length. The ♀, except for being larger, agrees well with Saussure's description, in which the ♀ only is mentioned, although his figure and the explanation of the plate are marked ♂. If Saussure knew the ♀ only, the designation of his figure is an error, the ♂ in the Macleay Museum would be the allotype, and I tentatively regard it as such. A few notes of the ♂ are added.

The ♂ closely resembles the ♀, but the anterior margin of the pronotum is not emarginate, nor tuberculate, and is more definitely reflexed; the discal irregularities are considerably more marked, a well defined trifoliate excavation with a tubercle on each side occupying the middle third of the disc. The postero-lateral angles of the 7th abdominal tergite are of the same form as in the ♀. The supra-anal lamina has its posterior margin slightly crenulate in the middle third (in the ♀ this is more marked, agreeing with Saussure's figure). Anterior femora 3-spinose. The larva closely resembles the adult, and also has the anterior femora 3-spinose.

Type material.—Allotype ♂, Macleay Mus., Sydney.

Habitat.—*Queensland*: Rockhampton; *N. S. Wales.*

Genus MACROPANESTHIA Saussure.

MACROPANESTHIA GIGANTEA Tepper (♂ only).

Geoscapheus giganteus Tepp. (♂ only), *Trans. Roy. Soc. S. Aust.*, 1894, p. 176. *Macropanesthia muelleri* Sauss., Rev. Trib. Panesth., *Rev. Suisse Zool.*, 1895, p. 329, Pl. ix, fig. 5.

I have examined Tepper's types of *G. giganteus* in the South Australian Museum. These are labelled "Type of ♂" and "Type of ♀"; they agree in the main with his description and measurements, but both are of the male sex, and they are not of the same species. His "Type of ♂" must stand as the holotype of the species, and Saussure's *Macropanesthia muelleri*, which is identical with it, becomes a synonym. Tepper's "Type of ♀" is really a ♂ of *Macropanesthia rhinocerus* Sauss., and Tepper's name for it, already occupied by another species, must go down as a synonym of Saussure's. The confusion may be due to Tepper's late indication of his types, and it is very improbable that when Saussure described *muelleri*, also from a ♂, he had seen Tepper's excellent description of it published a year previously.

In many of the *Panesthiinae* the 7th abdominal tergite and supra-anal lamina are bent downwards more or less sharply, their plane joining that of the proximal tergites at an angle, and presenting an extensive surface posteriorly. This surface is usually coarsely and densely punctate, and is frequently furnished around its borders with strong spines and crenulations. On account of this bending, the posterior margin of the sixth tergite becomes more prominent, is sometimes simply everted, but is more frequently also armed with crenulations or dentations, or, as in the present species, with a row of strong tubercles, in some examples almost spines, repeated, but less prominently, on the 5th and 4th tergites. *Plana crenulata* mihi shows these crenulations very well. *P. dilatata* Sauss. and his var. *major* also have them, but not *robusta* Tepp. In the genus *Panesthia*

several species such as *lata* Walk. and *sloanei* mihi show this armature in some degree; whilst *Hemipanesthia kraussiana* Sauss., which does not possess it, is of more depressed form, and may not be an earth digger. *Salganea morio* Burm. has the posterior margin of the 6th tergite entire, but the 7th makes up for this by being crumpled and having dentate lateral margins. I have kept specimens of the present species alive for several months in glass jars of sand, watched them going underground, and the whole apparatus seems to be most effective as an aid to the insects in burying; the abdominal somites are retracted, the smooth anterior portion of each sliding up beneath the preceding one, and the shortened abdomen with its posterior end, shaped and armed for the purpose, takes a good purchase against the collapsed back and sides of the burrow, thus enabling the fossorial tibiae and scoop-like anterior part of the pronotum to do their work, and to be thrust forward when the way is prepared.

As the ♂ only has been described, and I have several ♀ in my collection, I have selected one as an allotype, and add a few notes upon it.

♀. Much resembling the ♂, but the pronotum is relatively wider, the anterior margin is gently recurved medially, and slightly tumefied, but not tuberculate; the excavation of the disc is not so pronounced, and the portion of the disc behind the converging sulci is not excavated. The armature of the distal abdominal tergites is similar to that of the ♂. Supra-anal lamina with definite crenulations in the middle of the posterior margin. Anterior femora 2-spinose.

Length.—♂, 35.0-39.0 mm. (Allotype, 38.5 mm.).

Type material.—Allotype ♀, No. 0/2862, Coll. Q. Mus.

Macropanesthia rhinocerus Saussure.

Macropanesthia rhinocerus Sauss., Revis. Trib. Panesth., *Rev. Suisse Zool.*, iii, 1895, p. 329, Pl. ix, fig. 4.—*Geoscapheus giganteus* Tepp. (♀ only), *Trans. Roy. Soc. S. Aust.*, 1894, p. 176.

Saussure described the ♂ from Bowen, Queensland, and Tepper's "Type of ♀" of his *Geoscapheus giganteus* is really a ♂ of *M. rhinocerus* Sauss., sent to him from North Queensland by Mr. C. French. The National Museum, Melbourne, has two damaged specimens with no locality labels, and the Macleay Museum, Sydney, has a larval ♀ from Cleveland Bay, and this, the neighbourhood of Townsville, is the district from which *rhinocerus* may be expected.

Macropanesthia hirsuta, n. sp. Text-fig. 33.

♂ nigro-castaneous, except the disc of the abdominal sternites and portions of the legs, where the colouring is of a rich castaneous. Head finely punctate, margin of the clypeus and base of the labrum brownish. Pronotum anteriorly produced, covering the vertex, finely punctate and crumpled, two prominent tubercles with their apices recurved situate within the anterior margin, disc excavated, the excavation extending backwards to within 1 mm. of the posterior border. Meso- and metanotum laterally finely punctate. Abdominal tergites 1 to 6 laterally sparsely coarsely punctate; tergite 7 and supra-anal lamina coarsely punctate; postero-lateral angles of the 6th tergite not produced, but a large, erect, blunt tubercle is situate 2 mm. along the posterior margin; postero-lateral angles of the 7th tergite produced into strong divergent recurved spines; abdominal sternites coarsely punctate laterally. Anterior femora 2- or 3-spinose. Legs densely hirsute where they may come into contact with the body or with one another.

Length.—42 mm.

Type material.—Holotype ♂, S. Aust. Mus.

Habitat.—*Queensland*: Dalby (Mrs. F. H. Hobler).

Note.—The hairiness from which this species is named, is more abundant than in any other of the Panesthiinae known to me. It is more abundant in the group which live underground entirely (Tepper's Geoscapheusidae) than in those which live in rotten wood, and probably acts as a triturating agent to break up sticky soil, leaving the leg movements unimpeded.

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FOSSIL PLANTS FROM THE NARRABEEN STAGE OF THE HAWKESBURY SERIES.

By A. B. Walkom, D.Sc.

(Plates xxiv-xxxi, and one Text-figure.)

[Read 24th June, 1925.]

Introduction.

This paper contains the results of the examination of a large number of fossil plants from the Narrabeen Beds, in the collection of the Geological Survey of New South Wales, and a few specimens from the Australian Museum Collection, and I have to express my appreciation of the opportunity afforded me of studying these interesting collections. The figured specimens, with the exception of *Taeniopteris triassica* (Text-fig. 1), are in the collection of the Geological Survey of New South Wales.

The specimens examined were in the great majority collected by Mr. B. Dunstan, F.G.S., Chief Government Geologist of Queensland, while Lecturer in Geology at the Technical College, Sydney. Mr. Dunstan collected extensively from the beds at Turrimetta Head, a horizon approximately 150 feet below the base of the Hawkesbury Stage. Valuable additions to the collection in the Mining Museum were made by Mr. C. A. Sussmilch, F.G.S., Principal, Technical College, Newcastle.

The Upper Coal Measures (Permian) in New South Wales are followed, usually without apparent stratigraphical break, by the Hawkesbury Series which consists of three stages, Narrabeen, Hawkesbury Sandstone and Wianamatta, the Narrabeen Stage being the lowest.

The Narrabeen Stage has a maximum thickness of about 1,750 feet and consists mainly of fine-grained sandstones and sandy shales. The upper portion of the stage is formed by a thickness of about 130 feet of red and purple shales which serve to mark a conspicuous horizon dividing the Narrabeen Stage from the Hawkesbury Sandstone Stage.

The roof of the Bulli Coal Seam has been regarded as the upper limit of the Upper Coal Measures, and from the strata within a few feet above this seam a small flora has been described (Dun, 1910, 1911), including the following species:—

Glossopteris Browniana.
Schizoneura gondwanensis (= *S. australis*).
Cladophlebis cf. *Roylei.*
Rhipidopsis ginkgoides var. *Sussmilchi.*
Taeniopteris cf. *McClellandi.*

This small collection of species is obviously more closely related to the Permian flora than to the typical Mesozoic flora which appears higher up in the Narrabeen Stage, and is to be regarded as a remnant of the Glossopteris flora.

Although fossil plants are very abundant at certain horizons in the Narrabeen Stage and have been collected for many years, no description of any of the

collections has been published. Mr. W. S. Dun prepared lists of the plants determined from the different Stages of the Hawkesbury Series, and these lists were published in the account of the Western Coalfield (Carne, 1908, p. 42). Mr. Dun very kindly handed over to me, for examination, the collections and also the drawings which had been prepared for him by Mr. F. R. Leggatt and I have to express my gratitude to him for his generosity in this respect. The results of my examination confirm the determinations made by Mr. Dun as contained in the lists prepared by him.

The late R. Etheridge, Jr., described examples of *Schizoneura australis* (= *S. gondwanensis* Feistmantel) from olive-green shales of the Narrabeen Stage at 1,274 feet 6 inches in the Cremorne Bore (Rec. Geol. Surv. N.S.W., iv (1), p. 32), and a further specimen with fructification from 2,870 feet in the Sydney Harbour Colliery Shaft at Balmain (ibid., vii (3), p. 234). He also described a specimen from 1,410 feet to 1,417 feet 6 inches in the Cremorne Bore as *Sagenopteris salisburioides* R. M. Johnston (ibid., iv (1), p. 34).

The following is a list of the species described from the collection under examination:—

Phyllotheca australis Brongn.
Coniopteris sp., cf. *lobata* (Oldham).
Fern stems (? Osmundaceae).
Cladophlebis sp. (fertile).
? *Cladophlebis* sp. (sterile).
Thinnfeldia Feistmanteli Johnston.
Thinnfeldia lancifolia (Morris).
Thinnfeldia narrabeenensis Dun.
? *Sphenopteris* sp.
Taeniopteris Tenison-Woodsi (?) Etheridge Jr.
Taeniopteris crassinervis Feistmantel.
Taeniopteris triassica, n. sp.
Taeniopteris wianamattae (Feistmantel).
Williamsonia sp. (flowers).
Williamsonia sp. (stems).
Ginkgoites sp.
? *Rhipidopsis narrabeenensis*, n. sp.
Brachyphyllum angustum, n. sp.
Araucarites sydneyensis, n. sp.
Carpolithus sp.

The specimens have mostly been obtained from the shales about 6-8 feet above high-water mark at Turrimetta Head, just to the north of Narrabeen. The horizon of these shales is about 150 feet below the top of the Narrabeen Stage.

The result of the examination of this flora of the Narrabeen Stage is somewhat disappointing to one who knows the abundance of plants on some horizons. There is, however, some satisfaction in the knowledge that the descriptions herein will form a basis for future work as well as for future collecting, for it must be remembered that past collecting has all been without any guide as to which forms were known and which were unknown.

The flora of the Narrabeen Stage should be one of the most interesting of the Australian fossil floras when it is better known, as it is almost certainly of Lower Triassic age and floras of this age are not well known in the Southern Hemisphere. The occurrence of *Glossopteris* and *Schizoneura* in the basal beds shows that the upper Palaeozoic flora had not entirely disappeared at the commencement of the Narrabeen Stage, but these forms did not persist for long and are not known in association with the typical Lower Mesozoic flora in Australia.

Equisetales.

PHYLLOTHECA AUSTRALIS Brongn. Plate xxiv, figs. 1-3.

Phyllotheca australis Brongniart, Prodr. Hist. Veget. foss., 1828, p. 152; Etheridge, Geol. Pal. Qland, 1892, p. 189, Pl. 17, fig. 13.—(For full synonymy *see* Arber, 1905, p. 17.)

Fragments of equisetaceous stems are abundantly represented in the collections, but in only one specimen of those examined are the leaves preserved (Pl. xxiv, fig. 2). This specimen can be referred to *Phyllotheca australis*. The remaining examples are either stem impressions or pith casts, and while, strictly, they should only be determined as *Phyllotheca* sp. or even "Equisetaceous stems," there is every probability that they all represent the one species. Associated with the stems there are some examples of nodal diaphragms, one of them being figured on Plate xxiv, fig. 3.

The question might be raised as to whether any of the stems should be referred to the genus *Schizoneura*, but, in the absence, from the collections examined, of any foliage referable to this genus, and on account of the pith casts and stems being quite unlike any of the stems referred to *Schizoneura* from the Ipswich Series of Queensland, it seems probable that the examples from the Narrabeen Series represent stems of *Phyllotheca*.

Filicales.

Cyatheaceae.

? CONIOPTERIS sp. cf. LOBATA (Oldham). Plate xxix, figs. 4, 6.

Frond bi- (? tri-) pinnate. Ultimate pinnae long, narrow, 4-5 mm. broad, opposite or alternate. Pinnules small, ovate, attached by whole base; median vein present, not persistent to apex, together with several secondary veins which make an acute angle with the median vein, and divide once in their course to the margin.

These specimens appear to be close to those described as *Coniopteris lobata* from the Jurassic rocks of Graham Land by Halle (1913, Pl. 1, fig. 27; Pl. 3, fig. 13; and text-fig. 5). This species has been recorded also from Upper Gondwana rocks of India and from the Rhaetic of Poland.

Osmundaceae.

CLADOPHLEBIS sp. Plate xxiv, fig. 4.

The specimen figured appears to be an example of portion of a fertile frond of a species of *Cladophlebis*, possibly *C. australis*. It is very similar in general appearance to a fertile example of *C. denticulata* figured by Seward (1910, p. 345, fig. 258) from Yorkshire. It is, however, the only specimen of its kind among the collections and, in the absence of preservation of any details of structure, it is not easy to determine its true nature satisfactorily. It is quite different from the fertile specimens referred to *Cladophlebis australis* from the Ipswich Series of Queensland (*see* Walkom, 1917, p. 3, Pl. 7, 8).

? CLADOPHLEBIS sp. Plate xxiv, fig. 5.

Several specimens, very imperfectly preserved, probably represent isolated pinnae of a species of *Cladophlebis*. The pinnae are long, parallel-sided, about 2.6 cm. wide, with pinnules closely-set, opposite or alternate, and making a wide angle with the rachis. The pinnules have a distinct midrib and secondary veins (observed with difficulty in parts of the specimen) which make an acute angle with the midrib, and which divide once (?) in their course.

Thinnfeldieae.

THINNFELDIA FEISTMANTELI Johnston. Plate xxiv, figs. 6-9; Pl. xxv, figs. 1, 2.
(For synonymy *see* Walkom, 1917, p. 17.)

The description of this common Mesozoic species has already been given in a previous paper (Walkom, 1921, p. 9).

The specimens from the Narrabeen Series are typical examples and exhibit considerable variation in size. In some of the smaller examples the pinnules are more pointed than in the larger ones and may even be somewhat falcate. Some of the large specimens show very well the character of the pinnules seated directly on the rachis; those below the point at which the rachis divides are well separated from one another and are contracted at their base.

This species of *Thinnfeldia* seems very close to that figured by Zeiller (1903, Pl. vi-viii) as *Ctenopteris Sarrani*. Seward and Holttum (1921, p. 41) express the opinion that the two are probably specifically distinct; they also suggest that *T. Feistmanteli* would be more appropriately referred to the genus *Ctenopteris* in view of the fact "that the habit of the frond as a whole is recognized as an important character in distinguishing between such genera as Ctenopteris, Thinnfeldia and Ptilozamites." They do not, however, suggest that the other Australian species of *Thinnfeldia*, *T. lancifolia* and *T. odontopteroides*, should also be referred to *Ctenopteris*. The species recently described by me as *Thinnfeldia talbragarensis* (Walkom, 1921, p. 9) forms a connecting link between *T. lancifolia* and *T. Feistmanteli* and, as all four species of *Thinnfeldia* above-mentioned are characterized by their frond habit, in particular by the dichotomous forking of the rachis, it seems to me impossible to separate them generically and I am unable to agree with the suggestion that any one of them should be transferred to *Ctenopteris*.

In the collections there are several specimens like that figured on Plate xxiv, fig. 9. These may be fragments of fertile fronds of *T. Feistmanteli*. They do not show any detail of structure, exhibiting only the distribution of the sori and the shape of the pinna. They agree in these general characters with the specimen figured from the Ipswich Series of Queensland (*see* Walkom, 1917, Pl. 1, fig. 3).

THINNFELDIA LANCIFOLIA (Morris).

Plate xxv, fig. 3; Pl. xxvi, figs. 1-3; Pl. xxvii, figs. 1, 2, 4, 5.
(For synonymy *see* Walkom, 1917, p. 21.)

"Frond divides dichotomously into two linear pinnae which are inclined to one another at an acute angle. Pinnules vary in form with their position; the majority are elongate, tapering, with a rather acute tip, and have a distinct midrib which does not usually persist to the tip of the pinnule. The pinnules on the inner sides of the branches become smaller as the point of branching is approached, and gradually change from elongate acute to a rather ovate semicircular or more or less rhomboidal shape, without a midrib, the veins arising directly from the rachis. The pinnules on the rachis below the junction may be of either type. The venation is alethopteroid, the secondary veins being given off from the midrib at a rather acute angle. In the basal portion of the pinnules some of the veins come direct from the rachis; the pinnules are decurrent and are connected by a narrow lamina along the rachis" (Walkom, 1917).

This species is of common occurrence in the Lower Mesozoic rocks of Australia, and also occurs in the Stormberg Beds of South Africa.

THINNFELDIA NARRABEENENSIS Dun, MS.

Plate xxvi, fig. 4; Pl. xxvii, figs. 3, 6; Pl. xxviii, figs. 1-4.

Frond large, pinnate, dichotomous. Rachis strong, pinnules large, elongate, obtusely pointed, opposite or subopposite, with margins usually entire, occasionally broadly lobed. In the basal portion of the frond the pinnules are modified, being reniform to triangular and somewhat contracted at the base. The elongate pinnules have a prominent midrib, with secondary veins close, slightly curved, and branching. The basal pinnules have venation of the odontopteroid type.

This is a much larger and more robust type than any of the other Australian species of Thinnfeldia. The individual pinnules attain a size of 7.5 cm. long by 2 cm. broad; their form varies somewhat; they may be gradually rounded with blunt apices, or tapering to acute apices.

The species seems to be most closely related to those specimens described as *Danaeopsis Hughesi* from rocks of Rhaetic age in India, South Africa, China, Tonkin and Queensland. From this species it differs in its somewhat smaller size and in the secondary veins being less numerous and not branching as frequently.

Whether the two species should be referred to the same genus is a question about which there is some doubt. No fertile examples of *D. Hughesi* have been found and there does not appear to be strong evidence for referring the species to the Marattiales. The species *T. narrabeenensis* is closely associated with other species of *Thinnfeldia* and is linked with them by its general characters, and there would seem to be no justification for separating it from this genus, unless indeed, all the other Australian species at present referred to this genus are also moved.

It seems possible that the specimens referred to *Danaeopsis Hughesi* may have to be, at some future date, removed to the genus *Thinnfeldia*.

This species differs markedly from *Neuropteridium* in the venation and in the attachment of the pinnules to the rachis.

Filicales incertae sedis.

? SPHENOPTERIS sp. Plate xxix, fig. 5.

The fragment figured on Plate xxix, fig. 5 may be referred, provisionally, to *Sphenopteris*. It is portion of a bipinnate frond, with small pinnules, but no trace of the venation is preserved. In habit it may be compared with such species as *Callipteridium stormbergense* Seward (1903, Pl. viii, fig. 2) from the Stormberg beds of South Africa, and *Scleropteris crassa* Halle (1913, Pl. 4, figs. 4-9) from the Jurassic flora of Graham Land.

? FERN STEMS. Plate xxix, figs. 10, 11.

Several specimens represent plant stems covered with a series of spirally arranged, elongate oval structures which probably represent a crowded mass of leaf-bases. The leaf-bases are roughly 8 mm. in diameter and in one of the specimens they bear small U-shaped scars, which suggest the impression left by the trace of the vascular strand of the petiole in *Osmundites*. It seems probable that these stems are those of a fern, possibly belonging to the Osmundaceae.

TAENIOPTERIS TENISON-WOODSI (?) Etheridge Jr. Plate xxix, fig. 1.

(*See* Walkom, 1917, p. 32.)

The two leaves figured on Plate xxix, fig. 1 resemble *Taeniopteris Tenison-Woodsi* in the size and form of the leaf and also in the venation. The only

difference, a slight one, appears to be that the secondary veins in our examples are slightly curved in their course from midrib to margin whereas in examples of the species previously examined they have been generally straight.

The species has only been recorded in Queensland in beds belonging to the Ipswich Series or its equivalents. A fragment which probably represents the same species has been figured as *T. Carruthersi* from the Stormberg beds of South Africa (Seward, 1903, Pl. viii, fig. 5).

TAENIOPTERIS CRASSINERVIS (?) Feistmantel.
Plate xxix, fig. 2; Pl. xxxi, fig. 12.

Portion of a large *Taeniopteris* is figured on Plate xxix. It agrees with *T. crassinervis* except that the veins are somewhat closer in our specimen. The fragment figured on Plate xxxi, fig. 12 is probably portion of a specimen of the same species. *T. crassinervis* occurs in Queensland Lower Mesozoic rocks and in the Rajmahal Group in India.

TAENIOPTERIS TRIASSICA, n. sp. Text-fig. 1.

In a small collection of plants from the Narrabeen Stage, belonging to the Australian Museum, there are two examples of a *Taeniopteris* different from any

Text-fig. 1. *Taeniopteris triassica*, n. sp. (× ⅓). The veins shown here and there indicate the inclination of the secondary veins to the midrib. A portion is also shown (× ⅔) to indicate the nature of the venation.

hitherto described from Australia. The most complete of these (No. F 17820) is figured in Text-fig. 1.

The frond is simple, very long (32 cm.) and relatively narrow (5.8 cm.). The midrib is very prominent and persists to the apex which is obtusely rounded. The secondary veins make a wide angle (about 70°) with the midrib; they branch occasionally and there are about 11 of them per cm.

This very large frond is comparable in size with *T. crassinervis* which has been recorded from Mesozoic rocks in Eastern Australia but it is not so wide in proportion to its length, nor are the veins at right angles to the rachis. The other large Australian species, *T. wianamattae*, has veins closer together and is very different in shape from the present species.

In dimensions, *T. triassica* may be compared with *T. Jourdyi* Zeiller from the Rhaetic of Tonkin, but in this the secondary veins are very much more numerous (35 to 50 per cm.), and also with the European species *T. vittata*. Another comparison may be suggested with *Nilssonia taeniopteroides* Halle from the Mesozoic flora of Graham Land (Halle, 1913, p. 47). With regard to this latter comparison, however, further specimens would need to be obtained before the identity of the two could be proved, as it would be necessary to have some evidence of the mode of attachment of the lamina.

TAENIOPTERIS WIANAMATTAE (Feistmantel). Plate xxix, fig. 3.
(For synonymy *see* Walkom, 1917, p. 38).

The specimen figured on Plate xxix, fig. 3 appears to be the apical portion of a leaf of *T. wianamattae*. The secondary veins are numerous and make an angle of 60-70° with the midrib.

Cycadophyta.

? WILLIAMSONIA sp. (Flowers). Plate xxix, figs. 7-9.

Specimens which are not unlike some of the flowers referred to *Williamsonia* are not uncommon in the Narrabeen Series. As preserved they consist of a series of bracts (5 to 8 in number), petaloid in shape and radially arranged, borne on a stout peduncle. The bracts are 1.5 to 2.5 cm. long, and up to 8 mm. greatest breadth. In the most complete specimen the peduncle is 4 cm. long and 5 mm. wide.

All the specimens are merely impressions and do not show any further detail of the structure. Two of them are figured on Plate xxix, figs. 7, 8. They may be compared with examples described by Wieland from the Jurassic of Mexico (1913, Pl. 27, fig. 6) as *Williamsonia Tlazolteotl*. Associated with the specimens described are some (e.g. Pl. xxix, fig. 9) which show the expanded bracts viewed from above.

Attention may be drawn to the apparent absence of leaves which might be referred to the genus *Williamsonia*. It is probable that such will be found later, in view of the presence of these flowers (?) and of the stems described below.

? WILLIAMSONIA sp. (Stems). Plate xxx, figs. 1, 2.

Impressions of stems covered with leaf bases or petioles in spirally arranged series are referred tentatively to *Williamsonia*.

The impressions of the leaf bases are rhomboidal in shape, 6-7 mm. by 4 mm. One specimen has portions of the petioles attached.

These stems may be compared with numerous examples which have been figured by various workers, e.g. *Williamsonia* sp. figured by Berry (after Wieland) from the Liassic of Mexico (Berry, 1918, p. 347, fig. 6c); stems of *Williamsonia*, also from Mexico, figured by Wieland (1913, Pl. 34, 35); fern or cycad stems from the Liassic of Sweden, figured by Antevs (1919, Pl. 6, figs. 36, 41). They may also be compared with such stems as *Bucklandia indica* from the Lower Jurassic of India (Seward, 1917, p. 488, fig. 579).

Williamsonias range from Upper Palaeozoic to Cretaceous.

Ginkgoales.

GINKGOITES sp. Plate xxxi, fig. 1.

The specimen figured on Plate xxxi, fig. 1 represents a fragment of a leaf which may be referred to *Ginkgoites*. There does not appear to be sufficient of the leaf preserved for correct determination, and it is even possible that the fragment represents portion of a large *Baiera* such as *B. Simmondsi* which occurs in the Upper Triassic rocks of the Ipswich Series of Queensland (cf. Walkom, 1917a, Pl. 2).

? RHIPIDOPSIS NARRABEENENSIS, n. sp. Plate xxx, figs. 3, 4.

The two examples figured on Plate xxx, figs. 3 and 4 occur on the same specimen. Fig. 3 shows the leaf divided into a number (7) of wedge-shaped segments, and borne on a petiole. The veins are fine and numerous, about .5 mm. apart.

The habit of the leaf seems to remove it from *Psygmophyllum*, though attention may be drawn to a certain degree of resemblance to *P. Haydeni* which occurs in Permian rocks of India and Russia (see Seward, 1919, pp. 86, 90).

Dun (1910) described leaves from the roof of the coal seam in the Sydney Harbour Colliery (at the very base of the Narrabeen Beds) as *Rhipidopsis ginkgoides* var. *Sussmilchi*, and Seward (1919, p. 85) has suggested that they are probably referable to *Psygmophyllum*, which seems doubtful.

Coniferales.

BRACHYPHYLLUM ANGUSTUM, n. sp. Plate xxx, figs. 5, 6.

Examples of portions of sterile coniferous branches with short narrow obtusely pointed leaves arranged in spirals are referred to *Brachyphyllum*, this generic name being regarded as purely provisional. The branches are thin, the impressions being not more than 3 mm. wide, and the leaves would appear to be up to about 7 mm. long and only 1-2 mm. wide. The specimens may also be compared with sterile branches of *Voltzia* (Seward, 1919, p. 289) which is typically Permian to Lower Triassic and is very similar to *Ullmannia* (Permian) and *Walchia* (Upper Carboniferous-Permian).

? ARAUCARITES SYDNEYENSIS, n. sp. Plate xxxi, fig. 2.

Small cones, up to 3 cm. long and 2 cm. diameter, with cone scales arranged spirally, suggest the reproductive structures of some species of the present day *Araucaria*. They appear to occur abundantly on certain horizons and they resemble the male flowers of *A. excelsa* (Seward and Ford, 1906, p. 326, fig. 10) in appearance and in size. They are quite distinct from any other fossil so far found in Australian Mesozoic rocks.

Seeds.

CARPOLITHUS sp. Plate xxxi, figs. 3-5.

There are a number of oval seeds in the collection. These are up to 1.5 cm. long by 1 cm. broad, but none of them show details of their structure and it does not seem advisable to do more than refer them to *Carpolithus* sp.

Plantae incertae sedis.

A. The three specimens figured (Plate xxxi, figs. 7-9), resemble one another in having a series of lines radiating from a central area. The three, however, apparently represent distinct types. Reference may be made to their general similarity to specimens which have been figured as fruits of Williamsonia. Some of them may be compared with the examples of *Williamsonia pecten* figured by Nathorst (1909, Pl. 2, figs. 16, 17) from the Oolite of Scarborough and with fructifications described by Wieland (1913) as *Williamsonia Netzahualcoyotl* from Mexico.

B. Figure 6, on Plate xxxi is a drawing made by Mr. Leggatt at the same time as most of the others illustrating this paper. I have not seen the original specimen, but it is apparently one which might belong to *Stenorachis* or perhaps to *Beania*.

C. Plate xxxi, figures 10 and 11 represent other fragments which I am unable to determine but which seem worth figuring with the object of drawing attention to them in the hope that further collecting may reveal additional and more complete examples.

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EXPLANATION OF PLATES XXIV-XXXI.

The figures, with the exceptions noted below, were originally drawn, for Mr. W. S. Dun, by Mr. F. R. Leggatt. Some of them have been slightly modified, particularly as regards the venation, under my direction by Mr. P. T. Hammond, of the Geological Survey, who has also prepared the drawings of the following figures:—Plate xxiv, fig. 2; Plate xxix, figs. 10, 11; Plate xxx, figs. 1, 2; Plate xxxi, figs. 8, 9.

Except where otherwise indicated the figures are two-thirds natural size.

Plate xxiv.

Fig. 1.—*Phyllotheca australis* Brongn. Pith cast.
Fig. 2.—*Phyllotheca australis* Brongn. Two nodes showing the character of the leaf-whorl at the upper one.
Fig. 3.—*Phyllotheca australis* Brongn. A nodal diaphragm.
Fig. 4.—*Cladophlebis* sp. Possibly fragment of a fertile frond.
Fig. 5.—? *Cladophlebis* sp.
Figs. 6-8.—*Thinnfeldia Feistmanteli* Johnston. These figures indicate the variation in the type of pinnule.
Fig. 9.—*Thinnfeldia Feistmanteli* Johnston. Portion of a fertile pinna showing the arrangement of the sori.

Plate xxv.

Figs. 1-2.—*Thinnfeldia Feistmanteli* Johnston. Portions of large fronds. The venation is somewhat diagrammatic in figure 1.
Fig. 3.—*Thinnfeldia lancifolia* (Morris). Portion of a typical frond with some seeds (?) superposed.

Plate xxvi.

Figs. 1-3.—*Thinnfeldia lancifolia* (Morris).
Fig. 4.—*Thinnfeldia narrabeenensis* Dun. The venation is somewhat diagrammatic in this figure.

Plate xxvii.

Figs. 1-2.—*Thinnfeldia lancifolia* (Morris).
Fig. 3.—*Thinnfeldia narrabeenensis* Dun. The venation on the lower half of the middle pinnule in this figure is drawn accurately.
Figs. 4-5.—*Thinnfeldia lancifolia* (Morris). The venation in figure 4 is rather diagrammatic.
Fig. 6.—*Thinnfeldia narrabeenensis* Dun.

Plate xxviii.

Figs. 1-4.—*Thinnfeldia narrabeenensis* Dun. Figure 2 shows the basal part of a frond, figures 1 and 3 the apical part.

Plate xxix.

Fig. 1.—*Taeniopteris Tenison-Woodsi* Etheridge Jr. (?).
Fig. 2.—*Taeniopteris crassinervis* Feistmantel.
Fig. 3.—*Taeniopteris wianamattae* (Feistmantel).
Fig. 4.—? *Coniopteris* sp. cf. *lobata* (Oldham).
Fig. 5.—? *Sphenopteris* sp.
Fig. 6.—? *Coniopteris* sp. cf. *lobata* (Oldham).
Figs. 7-9.—? *Williamsonia* sp. Flowers?
Figs. 10-11.—Fern stems (? Osmundaceae). Figure 11 shows one of the leaf bases enlarged.

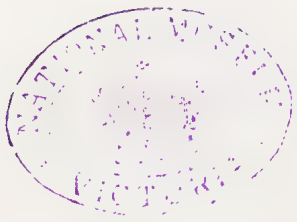
Plate xxx.

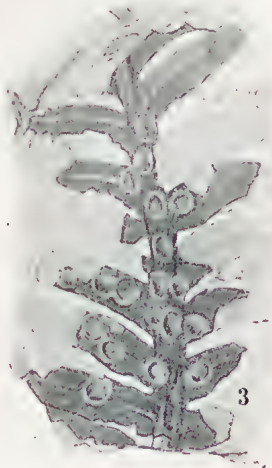
Figs. 1-2.—? *Williamsonia* sp. Stems.
Figs. 3-4.—? *Rhipidopsis narrabeenensis*, n. sp.
Figs. 5-6.—*Brachyphyllum angustum*, n. sp.

Plate xxxi.

Fig. 1.—*Ginkgoites* sp.
Fig. 2.—? *Araucarites sydneyensis*, n. sp. (× $^4/_3$).
Figs. 3-5.—*Carpolithus* sp.
Fig. 6.—Planta incertae sedis. (Possibly *Stenorachis* or *Beania*)
Figs. 7-9.—Plantae incertae sedis.
Figs. 10-11.—Indeterminate plant fragments.
Fig. 12.—*Taeniopteris crassinervis* Feistmantel.

1-3. *Phyllotheca australis.* 4, 5. *Cladophlebis* sp. 6-9. *Thinnfeldia Feistmanteli.*





1, 2. *Thinnfeldia Feistmanteli.* 3. *T. lancifolia.*

1-3. *Thinnfeldia lancifolia.* 4. *T. narrabeenensis.*

1, 2, 4, 5. *Thinnfeldia lancifolia.* 3, 6. *T. narrabeenensis.*

Thinnfeldia narrabeenensis.

1. *Taeniopteris Tenison-Woodsi.* 2. *T. crassinervis.* 3. *T. wianamattae.*
4, 6. ? *Coniopteris* cf. *lobata.* 5. ? *Sphenopteris* sp. 7-9. ? *Williamsonia* sp.
10, 11. Fern stem.

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1, 2. ? *Williamsonia* sp. 3, 4. ? *Rhipidopsis narrabeenensis*.
5, 6. *Brachyphyllum angustum*.

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1. *Ginkgoites* sp. 2. ? *Araucarites sydneyensis.* 3-5. *Carpolithus* sp.
6-11. *Plantae incertae sedis.* 12. *Taeniopteris crassinervis.*

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REVISION OF THE AUSTRALIAN SPECIES OF *CHRYSOBOTHRIS* (FAM. BUPRESTIDAE), TOGETHER WITH NOTES, AND DESCRIPTIONS OF NEW SPECIES OF COLEOPTERA.

By H. J. Carter, B.A., F.E.S.

(Nine Text-figures.)

[Read 29th July, 1925.]

Sixteen names are recorded for Australian species of the genus, which are (as with other genera of Buprestidae) greatly confused in our collections. This is not surprising, since the general facies of different species is very similar so far as the upper surface is concerned.

Of the sixteen, I think I have clearly identified eleven. Of the remaining five I would note as follows:—

1. *C. peroni* L. & G. from Kangaroo Island is impossible to determine from the incomplete description (applicable to most of the species), while its figure is evidently incorrectly drawn, the narrow width compared with length being inconsistent with the dimensions as stated in description. An example from Mulwala (Murray River, Victoria) labelled *peroni* in the South Australian Museum is identical with *C. mastersi* Macl.
2. *C. auropunctata* Deyr. is described from New Guinea. Kerremans (*Gen. Ins.*) gives Australia also for this species, but its imperfect description prevents determination. I think it should be omitted from the Australian list until the type can be examined and compared with other species.
3. *C. regina* Kerr.—The curious wording of the description of the apex of abdomen apparently indicates the trispinose apex that is characteristic of *C. incana* Macl., but the elytra are said to have "cinq fossettes, deux à la base, une au milieu du disque . . . . deux au tiers posterieur." If this "one" is placed on the suture I have never seen an example. If, however, it is in the usual position it surely has its "fellow" on the other elytron. The wording may be a "lapsus calami" or the type may be a "freak" example.
4. *C. carteri* Obenb., from S. Queensland, described as having a non-carinate abdomen would point to the ♂ of my species (*C. octomaculata*, infra) but for two characters that are inconsistent with this—viz. (1) "circular coppery foveae superficial" on elytra, (2) underside "green in the middle, coppery on the sides." In some examples of *C. viridis* Macl. the carina is subobsolete, so that the very variable *viridis* may include *carteri* Obenb.
5. *C. blackburni* Obenb.—I cannot distinguish this from some examples of *mastersi* Macl. The only species with which Obenberger compares his three Australian species is *C. australasiae* Hope, and this is done so vaguely as to give little help, besides giving no indication of the species determined by him as *australasiae*. The species so determined by Kerremans (of which I have an example before me labelled *australasiae* by him from the British Museum) is clearly *mastersi* Macl.

The following synonymy seems certain, the doubtful cases being indicated by a (?):—

1. *C. incana* Macl. = *interioris* Blackb. = ? *regina* Kerr.

Macleay's type exactly corresponds with Blackburn's detailed description.

2. *C. saundersi* Macl. = *hopei* Obenb.

The description of the latter exactly corresponds with Macleay's type.

3. *C. viridis* Macl. = *frenchi* Kerr. = ? *simplicifrons* Kerr.

Kerremans's descriptions do not indicate any clear distinction from the variable *C. viridis* Macl.

C. frenchi Kerr.—The type has lost the head and thorax. Its inadequate description had led me to consider it as a synonym of the variable and widely distributed *C. viridis* Macl., while the drawing and notes sent me of its abdomen are quite in conformity with this synonymy.

C. simplicifrons Kerr., is, I think, doubtfully distinct from *C. viridis* ♀, though at present I cannot definitely call it a synonym. I have an example from the Dorrigo, N.S.W., which corresponds with Mr. Blair's notes on the type. The apex of abdomen is rather squarely emarginate, with sharply defined medial carina (as is the case with the ♀ of *C. viridis*, the ♂ often having this carina vaguely defined), the underside duller aeneous instead of brilliant green, eyes slightly wider apart, etc.

Distinctive Characters.—The most distinctive characters that separate the species are found on the underside, especially in (*a*) the structure of the apical segment of the abdomen, (*b*) the colour and sculpture of the abdomen. Further differentiating characters lie in (*c*) the form and sculpture of the prothorax, (*d*) the micro-sculpture of the elytra and the form of the elytral foveae (fossettes). Finally, the size and colour may be helpful as secondary considerations, but are often fallacious guides. The occurrence of dwarfs—probably due to malnutrition of the larvae—is well known to collectors, while the ordinary variations of size in the species of wide distribution are considerable. In the long series (24 examples) of *C. mastersi* Macl. before me, the dimensions vary from 16 × 6 to 10.5 × 4 mm., and of *C. incana* Macl. from 20 × 7 to 12 × 4.5 mm., the females in general being larger than the males.

Colour.—The colour of the upper surface is singularly uniform, compared with species of other genera. In general, more or less violet bronze, sometimes greenish or olivaceous, the colours, in old specimens, become nearly or quite black. In all the Australian species examined by me—with the slight but constant modification noted in *C. octomaculata* infra—the elytra have six foveate depressions, three on each elytron, of a brilliant metallic copper or green, similarly placed; though an obliteration of this metallic colouration by age or chemical action would seem to account for the different number of these recorded in descriptions.

The size of these foveae seems constant in the same species, but varies in the genus sufficiently to serve as a useful aid in diagnosis. The first pair are placed within the angles formed by the prominent basal lobes, the second pair are medial on the 2nd costae, the third pair on the apical third, on the 3rd costae.

Elytral sculpture.—In general there are four well-marked costae on each elytron, besides a short scutellary costa; but in some species only the first costa (nearest the suture) is clearly defined, parts of the others being indicated. The costae are prominent in *mastersi*, *incana*, *subsimilis* and *amplicollis;* less so in *saundersi* and *australasiae*, and vague in *viridis* and (?) *frenchi*.

An excellent character—requiring a good lens or (better) a good binocular microscope—is the micro or ground sculpture of the upper surface, always

constant for the species, but with considerable variation in the genus. Thus *australasiae* Hope is distinguished by more transverse rugae (very strong on pronotum); *arcana*, *mastersi* and *saundersi* have round punctures distinctly separated, with different degrees of density and size; *viridis* is scarcely punctate, but scalose, as in many *Cisseis; saundersi* and *amplicollis* are distinguished in having the pronotum almost entirely punctate, little strigose.

Form of Prothorax.—The sides of prothorax are, in general, not very variable; the majority of species having what Thomson called "subhexagonal" outlines, the sides contracting obliquely in front and behind, with a larger medial space, sometimes concave.

The following notable exceptions to the above are as follows:—in *australasiae* Hope, the sides widen from apex to near base, where they are rather abruptly and bluntly rounded (vide Saunders' figure, *Trans. Ent. Soc. Lond.*, 1868); in *amplicollis* Thoms. the sides have a distinct bulge and are widest at the apical third; in *viridis* Macl. the sides are nearly straight, or feebly undulate.

Abdominal characters.—The apical segment is strongly carinate in *mastersi*, *saundersi*, *arcana;* feebly so in *australasiae*, *viridis* ♂ and in the ♀ of *amplicollis*, and *non*-carinate in *subsimilis*, *caelatus*, n. sp., and *carteri* Obenb., while the carina appears only in the female of *octomaculata.* The abdomen is varicoloured, chiefly golden with blue or violet apical margins to segments in *australasiae*, *mastersi*, *amplicollis* and *octomaculata*, concolorous in *arcana*, *saundersi* and *subsimilis*—the second of these almost black—and chiefly bright green with purple patches in *viridis.* The structure of the apices varies sexually, the ♂ generally having the wider excision, and often bispinose; *arcana* is remarkable for its trispinose apex, the carina being produced into a medial spine; *subsimilis* is exceptional in having a forked tooth on each side of a wide triangular excision and may thus be said to be 4-spined. The apical excision is small in *saundersi* and in the ♀ of *australasiae.*

Distribution and Habit.—As with many other Buprestidae, some of the species have a very wide distribution. Thus, of the longer series before me, 33 of *arcana*, 19 of *viridis*, 24 of *mastersi*, 10 of *subsimilis*, I find that the first occurs widely in N. W. Australia and Queensland (1 ex. from Narrabri, N.S.W.); *mastersi* occurs in Queensland, Western Australia, South Australia, N. Victoria; *saundersi* in Queensland and Western Australia; *viridis* in Queensland, New South Wales, and Western Australia; *amplicollis* in Western Australia and South Australia, *subsimilis* in Queensland, Western Australia and Victoria.

Mr. J. Clark tells me that they frequent acacias, like *Melobasis*, and fly rapidly at the least disturbance. They are comparatively rare, few collections having them in any number. I have, however, been able, with the courteous assistance of my colleague entomologists of the British Museum and of all the Australian Museums, to examine a large number of species—many examples compared with types—as well as the Macleay types.

The following are undescribed:—

CHRYSOBOTHRIS CAELATUS, n. sp.

♂. Robust, widely oblong-ovate, above and below obscure violet-bronze, the depressed areas of pronotum and the six elytral foveae coppery, middle of abdomen obscure green.

Head with embossed surface, rather strongly pilose, a curved "horse-shoe" impression between the eyes, with three elongate, shining nodules in front of this and smaller irregular nodules near epistoma, the last feebly sinuate, interocular

area wide and sulcate-carinate (a short linear sulcus between carinate margins), frontal area regularly punctate, antennae wanting. *Prothorax*: Apex subtruncate, base very sinuous, medial lobe rather strongly produced and truncate at scutellum, widest in front of middle, sides angulately jagged, with a strong triangular emargination at apical third, thence irregularly narrowed to base, all angles produced and acute. Disc with wide medial sulcus, its basal third smooth, surface irregularly embossed; rugose-punctate near middle, with larger nitid knobs towards sides, with an underlying system of coarse punctures. *Scutellum* triangular, smooth. *Elytra* rather convex, thrice as long as prothorax and one-third wider than it, with six large, rather deep, coppery foveae in the usual positions, the basal and post-medial round, the medial rather square; the usual costae evident but not strongly raised, the surface punctures stronger than usual—larger and more widely separated than in *C. mastersi*—with some rugae apparent near costae and at sides; margins behind finely serrate, underside coarsely punctate, the abdomen longitudinally rugose-punctate; apical segment of abdomen subcarinate, a short, rather flat, smooth, longitudinal rugosity forming a sort of carina; apex with wide concave excision, dentate at extremities.

Dimensions: 17 × 7.2 mm.

Habitat.—New South Wales: Mossgiel (in Australian Museum).

Type, No. K.32692 in Australian Museum.

♀ has the elytra more sharply attenuated to apex, the apical segment scarcely excised, the carina less evident (sub-obsolete). Paratype, No. K.32691 in Australian Museum.

The female example is labelled Mitchell River, and, though differing as above, is clearly conspecific with the Mossgiel example. It is the widest and most convex of the Australian species, and it may be differentiated by its roughly embossed pronotum with its dentate sides. Name from *caelare*, to emboss.

Chrysobothris octomaculata, n. sp.

Ovate, dark purple-bronze above, elytra with six large circular coppery foveae, together with an oblique elongate spot adjacent and exterior to the medial foveae; underside brilliantly varicoloured, metasternum and segments of abdomen golden-green and purple, the latter violaceous at anterior margins and sides, underside of femora golden-green and purple, tarsi blue.

Head sparsely pilose, rugose-punctate, depressed parts coppery, epistoma with arcuate triangular excision, eyes moderately converging behind, interspace slightly wider than in *viridis* Macl., longitudinally wrinkled on vertex. *Prothorax* short and transverse, sides subhexagonal, sometimes undulate, with a small concavity in middle, more strongly and subsinuately narrowed behind than in front, equally wide at anterior and basal third, all angles produced and acute. Disc with medial line generally indicated by short depression, a wide transverse depression near apex, two shallow foveae on posterior half, surface finely, transversely rugose-striolate. *Scutellum* triangular. *Elytra* more than thrice as long and nearly one and a half times as wide as prothorax, shoulders unusually squarely rounded, thence to apical third sub-parallel, margins on apical half rather strongly serrated, usual costae vague, often sub-obsolete on basal half—except the presutural—a wide convexity (not carinate) running obliquely from the shoulder separates the medial fovea from the adjacent coppery mark, a wide depression following its course within this; surface minutely, densely and clearly punctate. Metasternum sparsely punctate, abdomen longitudinally rugose-punctate, apical segment *non-*

carinate, slightly depressed in middle, with wide square excision limited by two prominent teeth; front femora with wide obtuse tooth.

Type ♂, No. K.32689 in Australian Museum.

♀ differs in having the apical segment of abdomen clearly but not prominently carinate, with a narrower, semicircular excision limited by two wider teeth.

Type ♀, in Macleay Museum.

Dimensions: 9-12 × 4-5 mm.

Habitat.—Queensland (Duaringa, Port Denison, Charters Towers, Brisbane).

Ten examples are before me, five of each sex; the sexes only distinguishable as above, being alike in form, size, and in the unusual ornamentation of the additional coppery spot, forming an adjunct to the medial fovea but always separated from it. Three examples from the Macleay Museum include both sexes labelled Port Denison in Mr. Masters's handwriting. The female is near *C. blackburni* Obenb., but besides coming from Western Australia this species is said to have the foveae as in *australasiae* Hope, which is not the case with *octo-maculata*.

Var.—Two ♀ examples (one from the British Museum) are only to be distinguished from the above by the absence of a clearly shown additional mark exterior to the medial spot.

Table of Australian *Chrysobothris*.

1.	Apex of abdomen 4-spinose	*subsimilis* Thoms.
	Apex of abdomen 3-spinose	*incana* Macl.
	*Apex of abdomen 2-spinose	2
2.	Form wide (7 mm.), sides of pronotum angulately toothed	*caelatus*, n. sp.
	Form normal (less than 6 mm. wide), sides of pronotum not so toothed	3
3.	Pronotum widest near base	*australasiae* L. & G.
	Pronotum not widest behind middle	4
4.	Sides of pronotum with obvious enlargement in front of middle	*amplicollis* Thoms.
	Sides of pronotum nearly straight	*viridis* Macl.
	Sides of pronotum subhexagonal (subequally attenuate each way)	5
5.	Apical segment of abdomen carinate in both sexes	6
	Apical segment of abdomen carinate only in ♀	*octomaculata*, n. sp.
6.	Underside concolorous (nearly black)	*saundersi* Macl.
	Underside brilliantly varicolorous	*mastersi* Macl.

The following captures are chiefly the outcome of two very interesting expeditions:—(1) With the Royal Australasian Ornithologists' Union camp at Byfield, near Yeppoon (Rockhampton district, Queensland) in October, 1924; (2) with the University Expedition, organized by Professor Launcelot Harrison, of Sydney University, to Barrington Tops, New South Wales, in January, 1925.

Astraeus intricatus, n. sp. Text-fig. 1.

Nitid, head metallic greenish at apex, purple at base, pronotum metallic purple, brighter at sides, elytra cyaneous, with the following yellow markings on each; an elongate oval basal spot, an elongate lateral mark extending from shoulder to about the middle, having an oblique inward extension over four lateral intervals, an irregular postmedian, subfasciate mark connected with a subsutural club-shaped spot extending forward behind the basal spot, and also with a triangular mark extending backward to the base of apical spine; underside and femora brassy bronze, tibiae and tarsi testaceous, antennae purple coppery.

Head closely and strongly punctate, longitudinally carinate in middle, and, like the pronotum, clothed with fine yellow hair. *Prothorax* obliquely narrowing

* *Australasiae* L. & G. has the apex of abdomen arcuately excised in ♂, with a small triangular excision in ♀, non-spinose in both sexes; but has been included under 2-spinose species from the difficulty of clear distinction between this structure and some of the 2-spinose species.

from base to apex, sides scarcely arcuate, apex nearly straight, base strongly bisinuate, medial line indicated on basal half by narrow smooth space, on apical half by wide depression; whole surface coarsely punctate, the sculpture close and subrugose at sides, more sparse on disc. *Elytra* striate-punctate, the striae outlined by finely cut costae, intervals between costae flat, containing shallow punctures, elytra divergent and bispinose at apex, the sutural spine robust; prosternum coarsely, abdomen finely and rather closely, punctate; underside rather densely tomentose.

Dimensions: 10 × 4 mm.

Habitat.—New South Wales: Monaro district.

A single male example in the Macleay Museum appears to be nearest to *A. vittatus* V. d. Poll. from N. W. Australia; but the pattern of the elytral colours is distinct, while there are other colour differences, e.g. *vittatus* has the pronotum bronzy green in middle, and the head black with purplish reflections.

Type in the Macleay Museum.

STIGMODERA (Subgen. CASTIARINA) HARRISONI, n. sp. Text-fig. 2.

♀. Oblong-ovate; head, pronotum, underside and appendages brilliant brassy green, the basal area of pronotum showing slight purplish gleams. Elytra blue-green with the following light markings on each—a sub-basal triangular spot (having two of its sides parallel to base and suture respectively) connected with a blood-red lateral mark behind the shoulder; a narrow, lunate, medial spot reaching neither side nor suture, a short narrow preapical fascia extending obliquely backward from the 4th interval, connected with a blood-red lateral macula extending over three lateral intervals backwards, half-way between the fascia and apex; the discal markings yellow.

Head excavated and channelled between eyes; irregularly punctate, the punctures small and close near base. *Prothorax* widest at base, arcuately narrowed to, and subsinuate near, apex; moderately bisinuate at base and apex, posterior angles rectangular, anterior acute; disc without medial sulcus, save for a large basal fovea; two punctate excisions at base (half-way between scutellum and side); disc irregularly punctate, the punctures nowhere dense, but closer and finer on apical half. *Scutellum* large, triangular, depressed in middle and finely punctate. *Elytra* rather flat, of same width as prothorax at base and thrice as long as it, sides slightly widened at shoulder, very feebly compressed behind this, slightly widest behind middle; apices widely bilunate, with a defined but short external tooth, the sutural angle at apex separately rounded and feebly produced; margins entire; striate-punctate, intervals quite smooth and nearly flat, underside glabrous and finely punctate, sternum sparsely, abdomen densely so; last segment rounded behind.

♂ latet.

Dimensions: 17 × 6.4 mm.

Habitat.—New South Wales: Barrington Tops.

A beautiful species belonging to the *producta* Saund.-*spectabilis* Kerr. group, that would stand next to the latter in my tabulation, from which it differs as follows:—(1) Larger size and flatter form; (2) apices wider with less pronounced teeth; (3) quite differently shaped yellow maculae (the sub-basal triangular, the four hinder being narrowly fasciate); the same in *spectabilis* being larger and round.

A single specimen taken by the University expedition is dedicated to Professor Launcelot Harrison, who so ably organized and conducted the research on Barrington Tops in January, 1925.

Type in the Macleay Museum.

STIGMODERA SUBVERSICOLOR, n. sp.

♂. Elongate, cylindric; head, underside, and appendages coppery, pronotum dark blue with undefined violet-coppery margins; elytra blue (in one example violaceous) with the following markings yellow:—two large post-basal spots* in general produced to basal margin, thence again backward to beyond the humeral swelling; four rounded spots midway (two discal spots in advance of two marginal), a preapical undulate fascia, widely interrupted at the suture, widening in each direction on margins.

Head deeply excavated and channelled, closely uniformly punctate. *Prothorax* rather tumid, apex subtruncate, base moderately bisinuate, sides well rounded, more strongly converging to apex than to base, feebly sinuate near the produced, acute hind angles; disc with medial channel distinct, not deep, closely punctate, the lateral sculpture becoming coarse and subrugose. *Elytra* at humeral swelling slightly wider than prothorax, feebly constricted behind this, apices slightly divergent and finely bispinose; margins entire; striate-punctate, the intervals clearly punctate and evenly convex on apical, flat on basal half; underside rather closely clad with white recumbent hair.

♀. Pronotum more or less concolorous (in one example greenish-blue), underside bronze-black.

Dimensions: 10-11 × 3.5 mm.

Habitat.—Western Australia: Tammin (Mr. J. Clark).

Four examples, two of each sex, sent by my friend, Mr. Clark, show a species more robust in form, but close in pattern to *S. versicolor* L. & G. In all examples of *versicolor* that I have seen, the pronotal margins and underside are a brilliant metallic green in both sexes; while in the above described the sexual colouration is marked, while the pronotal metallic gleams are only noticeable in one example under observation and in this case with ill-defined limits. In three examples of *versicolor* before me, the prothorax is more parallel and less tumid than in my species, while the preapical fascia does not extend to the sides in two examples, and just reaches them in the third. The variable post-basal markings occur in both species.

Type in Coll. Carter.

Archaeozodes strandi Obenb. = *Stigmodera versicolor* L. & G.

Dr. Obenberger's description exactly tallies with this well known species. The genus *Archaeozodes* is thus redundant.

Dr. Obenberger persistently describes Australian Buprestidae as new species on very finely drawn differences. Thus in *Archiv für Naturgeschichte*, 1924, p. 69, one of the most widely distributed of Australian insects known as the fire beetle,† *Merimua atrata*, is redescribed as *M. corporaali* from New Guinea. I have specimens from an island in Torres Strait which correspond with his description, but which I consider but slight variation from the normal. Such variations may be found by examining long series of most common insects. Again *Briseis*

* In one example the post-basal spot is isolated from the marginal yellow area.

† From its curious habit of settling on hot ashes from camp and bush fires, slag heaps and its attraction to strong light.

sagitta Obenb. (p. 68 of the same publication) cannot, I think, be differentiated from the well known *B. conica* L. & G.

Neotorresita achardi subsp. *occidentis* Obenb.—I have already stated (THESE PROC. 1924, p. 526) that *Neotorresita achardi* Obenb. = *Pseudanilara cupripes* Macl., and have in the same place described as new, *Ps. occidentalis*, with clear distinction from its allies. This is apparently not the subspecies noted by Obenberger. The names *occidentis* and *occidentalis* are unfortunately close.

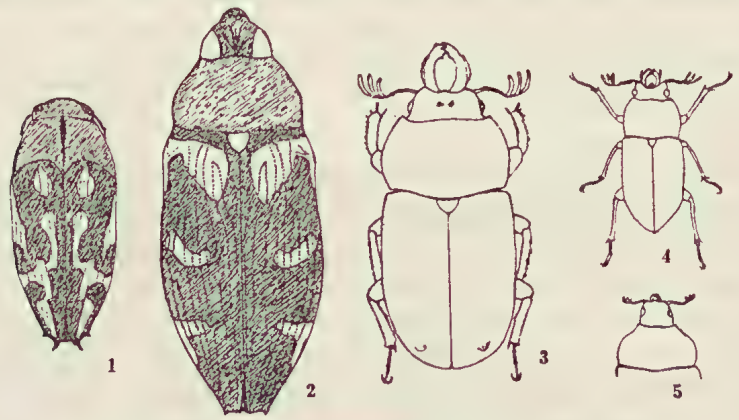
Paracephala impressicollis Obenb. must be very near *P. trans-secta* Cart., but in his description, the author does not indicate the relation of species to *P. trans-secta* Cart., nor indeed to any other member of the genus. This omission constitutes a serious deficiency in descriptions, especially in the case of genera in which the species are difficult to identify, as in *Cisseis*. Thus *Cisseis carteri* Obenb. (p. 109 of the above) is described without even a reference to the groups into which I divided the species in the "interessante Bearbeitung" politely mentioned by Dr. Obenberger. The same remark applies to the descriptions of five species of *Cisseoides*—a genus which Obenberger considers that I wrongly merged with *Hypocisseis*.

Lucanidae.

CERATOGNATHUS BITUMULATUS, n. sp. Text-fig. 3.

♂. Robust, brownish-black, sparsely clothed with yellowish-grey squamules, mandibles rather long, curved, without lateral or vertical auriculations, apices bidentate, with a third internal tooth, triangular, a little behind apex, the basal two-thirds with a laminate thickening having a sub-crenulate or granulose upper edge and terminating abruptly towards apex; clothed sparsely with silky hair and punctate externally.

Head punctate, with two round tubercles on front, eyes large and moderately prominent, the flabellae as long as the rest of the antennae. *Prothorax* feebly bisinuate at apex, more strongly so at base; sides rather widely and evenly rounded, all angles obtuse; lateral margins uniformly, horizontally explanate, extreme border crenulate, disc regularly and rather closely punctate, medial line smooth and slightly convex on basal half, an oval, slightly flattened depression



Text-fig. 1. *Astraeus intricatus*, n. sp.
Text-fig. 2. *Stigmodera (Castiarina) harrisoni*, n. sp.
Text-fig. 3. *Ceratognathus bitumulatus*, n. sp.
Text-fig. 4. *Ceratognathus ocularis*, n. sp. ♂.
Text-fig. 5. *Ceratognathus ocularis*, n. sp. ♀.

on apical half. *Scutellum* semicircular, punctate. *Elytra* sub-parallel, wider than prothorax at base, somewhat irregularly punctate, the punctures tending to run in ill-defined longitudinal series, some sub-obsolete costae just visible; each elytron with a blunt, round tumulus on the apical declivity, more or less covered with squamules. Sternal area punctate, abdomen longitudinally rugulose. Fore tibiae more spinose than usual in the genus, with three strong apical spines and about six others of larger size than the usual marginal denticulations; hind tibiae a little swollen at middle on interior margin.

Dimensions (including mandibles): 14 × 6 mm.

Habitat.—New South Wales: Mt. Kosciusko (H. J. Carter, Jan., 1906) and Barrington Tops (H. J. Carter, Jan., 1916).

♀. Rather wider and more oval, the mandibles short and stout, the antennal flabellae much shorter. *Dimensions*: 13 × 6 mm.

Three examples examined, ♂ and ♀ from Kosciusko, and a ♀ from Barrington Tops, show a species clearly separated from its nearest relative *C. gilesi* Blkb., by the presence of the elytral tumuli and the differently formed mandibles of the ♂. *C. gilesi* also has a single large tubercle on the head, the pronotum has smooth spaces, the margins are not explanate, and there is a deep medial sulcus. From *C. flabellatus* Boil., and *C. macrognathus* Boil. it differs *inter alia* by the differently shaped prothorax—in both these species the sides being "presque droits."

Types in the National Museum, Melbourne.

CERATOGNATHUS OCULARIS, n.sp. Text-figs. 4, 5.

♂. Oblong, convex, brown, whole upper surface with sparse golden squamules.

Head, as with the whole upper surface, cellulose-punctate, frontal area without tubercles, clypeus trilobate, the antennal orbits forming acute convex lobes pointing obliquely forward, a third smaller subconical process jutting horizontally from the middle of the clypeal area, mandibles short, wide seen sideways, non-auriculate, trifid at tips, the middle tooth longest; eyes round and very prominent, antennae slender, the leaflets nearly as long as rest of antennae. *Prothorax*: Sides rather strongly and evenly rounded, anterior angles subacute, posterior obtuse, margins a little explanate, extreme border minutely serrulate in places; medial sulcus wide throughout and emphasized by a line of golden squamules on each side, more uniformly placed than elsewhere. *Scutellum* large, oval. *Elytra* parallel, convex, wider than prothorax at base, suture on apical half widely costate and with three other, fairly well defined, wide, subcostate impressions continuous from base to apical declivity. Legs slender, fore tibiae finely serrate on exterior edge, having one larger spine on apical third besides the longer but fine apical spines; tarsi very slender, hind tarsi with claw joint as long as the rest combined. Underside coarsely punctate, the punctures close on abdomen, more distant on sternal area, prosternum carinate.

♀. Differs in having the head much narrower, without the defined clypeal lobes, eyes not prominent, mandibles very short, the antennae with leaflets about half as long as in ♂; prothorax having anterior angles close to head, followed behind by a wide sinuation; size generally larger.

Dimensions: ♂, mandibles included, 7.5 × 3 (+), ♀ 8 × 3.5 mm.

Habitat.—New South Wales: Barrington Tops (Sydney University Expedition); Mount Wilson (H. J. Carter).

Twelve examples (4 ♂, 8 ♀) show the smallest of the described Australian species, distinguished by unusual sexual characters, e.g., clypeal structure, promin-

ent eyes of ♂, differently shaped prothorax, besides the usual differences found in the mandibles and antennae. A single ♀ only from Mount Wilson.

Type series in Macleay Museum, University of Sydney.

Table of Australian Species of *Ceratognathus* Westw.

1.	Mandibles of ♂ with erect lateral horn	2
	Mandibles of ♂ without erect lateral horn	3
2.	Lateral horn acute	*niger* Westw.
	Lateral horn laminate (subquadrate)	*froggatti* Blkb.
3.	Mandibles of ♂ with careniform enlargement on upper margin terminating in a dentiform process	4
	Mandibles of ♂ not so	5
4.	Colour chestnut-brown	6
	Colour fuscous-black	7
5.	Mandibles of ♂ with round medial lobe on inside margins	*mentifer* Westw.
	Mandibles without lobes or lateral tooth	8
6.	Mandibles curved, sides of pronotum rounded	*westwoodi* Thoms.
	Mandibles and sides of pronotum nearly straight	**macrognathus* Boil.
7.	Pronotum strongly sulcate, with smooth areas	*gilesi* Blkb.
	Pronotum not (or scarcely) sulcate without smooth areas	*bitumulosus*, n. sp.
8.	Size large, 15 mm. (or more) long, sides of pronotum nearly straight	9
	Size small, less than 9 mm. long, sides of pronotum rounded	10
9.	Erect tooth on clypeus above each eye	*frenchi* Blkb.
	This clypeal tooth absent	**flabellatus* Boil.
10.	Head with frontal tubercle, transversely bipartite	*rufipennis* Westw.
	Head without such tubercle, clypeus tricristate	*ocularis*, n. sp.

Although the species described by M. Boileau are unknown to me in nature, they are described in such detail—one is also well figured—that I have ventured to include them in the above table. This table only takes into account the male characters; the females would be difficult, in some cases impossible, to tabulate. *C. abdominalis* Parry from Moreton Bay, Queensland, was described from a unique ♀. Monsieur Boileau has suggested its probable synonymy with *C. froggatti* Blkb.

Tenebrionidae.

Saragus wilsoni, n. sp.

♂. Widely ovate, rather depressed, glabrous, the greater part of surface reddish-brown, foliate margins, antennae and tarsi castaneous, pronotum, prosternum, greater part of head and medial area of abdomen black.

Head minutely and irregularly punctate, epistoma straight in front, oblique with reflexed margin at sides, eyes separated by a space of the width of one eye, antennae with joint 3 nearly as long as 4-5 combined, 4-8 successively shorter, 9-10 nearly round, 11 oval. *Prothorax*: Disc convex, foliate margins wide and concave, total width : width of disc as 11 : 8. Anterior angles advanced and bluntly rounded, posterior acute and falcate, lateral border fine and reflexed; disc microscopically punctate, medial line very lightly impressed, without evident basal foveae. *Scutellum* transversely oval. *Elytra* ovate, of same width as prothorax at base, and rather more than twice as long; foliate margins as wide as the pronotal, continuous to, but narrowed at, apex; the red colour dotted through with round, black, subdermal spots, seen alike from above and below; border narrowly reflexed, disc nearly smooth, with a few subobsolete costae faintly indicated and (with a lens) line of minute punctures just visible, except near sides, where, besides the usual lateral row of large punctures, the adjacent two or three rows of small punctures clearly shown; prosternum finely transversely

* Unknown to author.

striolate and sparsely pustulate, episterna more strongly rugose, abdomen minutely striolate; fore legs having two basal tarsi considerably widened, hind legs having basal tarsus as long as apical, the intermediate short.

Dimensions: 17-18 × 12 mm. ♀ wanting.

Habitat.—? Western Australia (C. French, per F. E. Wilson).

Two male examples sent by Mr. Wilson who obtained them from Mr. French with other Western species, unlabelled. The species is not much smaller than *S. magister* Pasc., from which it differs in colour, flatter elytra and smoother surface, almost impunctate to the naked eye, except at sides. It is much wider than *perlaevis* Cart. The curious subdermal spots on the elytral margins are characteristic, as are the wider basal tarsi of the fore feet, the latter being probably sexual. Both examples are similar in colour which may, or may not, be due to immaturity. Type in Coll. Carter. Paratype in Coll. Wilson.

NYCTOZOILUS LATERALIS, n.sp. Text-fig. 6.

Opaque brown-black, ovate, convex; tarsi and antennae reddish.

Head: Surface scabrous and subpunctate, rather abruptly widened at antennal orbits, forehead with deep, medial, longitudinal sulcus extending from base to clypeal suture, antennae having 3rd segment longer than 4th-5th combined, the 11th longer and narrower than 10th. *Prothorax* arcuate-emarginate at apex, anterior angles acute and prominent, the tips slightly blunted; base nearly straight in middle, sinuate near sides, posterior angles acutely produced backwards; sides evenly rounded, widest in middle, subsinuate near front and hind angles; the lateral border thick and convex, a deep and fairly wide sulcus within; disc sparsely rugose, without distinct punctures, a medial sulcus clearly shown on greater part of length, obsolescent near apex and base, a large irregular foveate depression on each side of this. *Scutellum* widely transversely triangular. *Elytra* wider than prothorax at base, widely rounded in humeral region; each with three finely crenulate costae, the exterior of these shortest and sometimes obscure, besides a geminate sutural costa bifurcating behind scutellum to join the first of above costae at base, the costae becoming obliterated on apical declivity; interstices irregularly rugose and subfoveate without reticulation or transverse ridges; the usual lateral row of large punctures irregular and often undefined. Beneath subnitid and almost impunctate, apical segments with very minute punctures; tibiae feebly tomentose; posterior tarsi with basal joint as long as the rest combined.

Dimensions: 16-17 × 8-9 mm.

Habitat.—Queensland: Byfield near Yeppoon (T. G. Sloane and H. J. Carter).

Three examples (2 ♂, 1 ♀) were taken under dead Eucalyptus branches. The species belongs to the first group of my table, where it would stand between *N. ruficornis* Cart., and *mastersi* Macl., having somewhat similar elytral sculpture to the former and the thick pronotal border of the latter. The strong frontal sulcus is a notable character. Type in Coll. Carter.

As eight species have been added since my tabulation of *Nyctozoilus* was published (*Ann. Q. Mus.*, 1911, p. 9), I append an emended table for the help of students.

Table of *Nyctozoilus* Guér.

1.	Pronotum rugose or squamose; not, or very vaguely, punctate	2
	Pronotum clearly punctate	8
2.	Lateral border of pronotum crenulate	*deyrollei* Bates
	Lateral border of pronotum entire	3

3. Elytra 6-costate, intervals not, or very vaguely, reticulate 4
Elytra 6-costate, intervals clearly reticulate 6
4. Lateral border of pronotum thin 5
Lateral border of pronotum thick ..... *lateralis*, n. sp.
5. Lateral border of pronotum reflexed, hind angles produced ..... *carbonarius* Cart.
Lateral border of pronotum sub-horizontal, hind angles not produced *ruficornis* Cart.
6. Lateral border of pronotum thin 7
Lateral border of pronotum very thick ..... *mastersi* Macl.
7. Pronotum coarsely rugose, anterior angles subrectangular ..... *obesus* Guér.
Pronotum smooth (felt-like), anterior angles acutely produced .... *denticollis* Cart.
8. Elytra reticulate, not costate ..... *irregularis* Blackb.
Elytra costate 9
9. Elytra 8-costate 10
Elytra 6-costate 15
10. Size large, 15-20 mm. long 11
Size small, 12 mm. long or less 13
11. Elytral costae undulate 12
Elytral costae straight ..... *puncto-costatus* Cart.
12. Elytral intervals irregularly reticulate (20 × 10 mm.) ..... *marginatus* Cart.
Elytral intervals foveate-punctate (16 × 9 mm.) ..... *crassus* Cart.
13. Elytral intervals clearly punctate ..... *pusillus* Cart.
Elytral intervals not (or very minutely) punctate 14
14. Elytral intervals with transverse ridges ..... **daemeli* Haag.
Elytral intervals subobsoletely vermiculate ..... *parvus* Cart.
15. Elytral intervals clearly reticulate 16
Elytral intervals obsoletely or indefinitely reticulate 20
16. Size large, 17-20 mm. long 17
Size small, 13 mm. long or less 18
17. Pronotal border thin, hind angles directed outwards ..... *reticulatus* Bates
Pronotal border thick, hind angles directed backward ..... *carlovillensis* Cart.
18. Pronotum very indistinctly punctate 19
Pronotum clearly punctate ..... † *inaequalis* Blackb.
19. Pronotal margins reflexed, extreme border thickened ..... *crassicornis* Blackb.
Pronotal margins horizontal, extreme border thin ..... *approximatus* Blackb.
20. Sides of pronotum sinuate anteriorly and posteriorly ..... *hardcastlei* Cart.
Sides of pronotum sinuate only posteriorly 21
21. Elytral intervals indefinitely reticulate ..... *vermiculatus* Cart.
Elytral intervals feebly wrinkled ..... *sexcostatus* Champ.

BYALLIUS ANGUSTATUS, n.sp. Text-fig. 7.

Elongate, ovate, convex, subopaque black; apical joints of antennae pale brown, tarsi beneath and apices of tibiae clothed with red tomentum.

Head finely punctate, epistoma truncate, forming an angle with antennal orbit; antennae enlarging to apex, joint 3 as long as 4-5 combined, 8-10 transverse, 11 oval. *Prothorax* considerably narrower at apex than at base, widest near base; apex arcuate-emarginate, anterior angles acutely produced forward, base subtruncate, sides very little widened, lightly widening to one-third of length, thence subangulately but feebly widening to middle third, thence roundly contracting behind, posterior angles obtuse; margins very thick and subvertically revolute, sulcate within; disc nearly smooth, punctures only to be seen with the aid of lens; without foveae or medial line. *Scutellum* widely triangular and shallow, with triangular depression behind. *Elytra* at extreme base narrower than prothorax, shoulders obsolete; narrowly ovate, apical declivity steep; disc vermiculately rugose-punctate, with three well-raised undulate costae besides the geminate sutural costa (bifurcating behind the scutellum), intervals irregularly rugose and punctate, a row of large punctures at sides. Underside minutely punctured, the

* I am a little doubtful of the distinction between *parvus* Cart. and *daemeli* Haag.
† Species unknown to the author.

first three abdominal segments with fine longitudinal wrinkles; post tarsi with basal segment nearly as long as the rest combined.

Dimensions: 15 × 7 mm.

Habitat.—New South Wales: Nerriga, between Goulburn and Braidwood (H. G. Carter).

A single example (? ♂) was lately taken by my son. It is very distinct from the six described species by the combination of smaller, especially narrower, form (of both prothorax and elytra), the strongly thickened and elevated border of pronotum with its minutely punctured disc. It is perhaps nearest to *B. ovensensis* Cart., in which, however, the pronotal border is narrower and less raised while the anterior angles are outwardly directed. Type in Coll. Carter.

Byallius (*Styrus*) *revolutus* Cart.—When describing *Styrus revolutus* (*Trans. Roy. Soc. S. Aust.*, 1914, p. 381) I commented on its marked distinction from other species of *Styrus* in the "entire, thickened, strongly revolute margins to prothorax—its truncate base" and its similarity to *Byallius* in the form of the prothorax. I now find that these characters point to its inclusion in *Byallius*, to which genus I would now refer it.

CHARIOTHES VARIPENNIS, n. sp.

Shortly oblong, glabrous and nitid. Head, pronotum and underside black, elytra varicoloured, legs red-brown, antennae, palpi and tarsi pale red.

Head: Epistoma semicircular, separating sulcus nearly straight, much more finely punctate than frontal area, the punctures on the latter rather coarse; antennal joints 1-2 short, 1-6 cylindric, 5-11 gradually increasing in width, 11th largest, oval. *Prothorax* subquadrate, wider than long, apex nearly as wide as base, the base produced a little backwards in middle, anterior angles widely obtuse, posterior rectangular, lateral border narrow, without foliation, an elongate depression near border, a transverse depression near basal margin, disc sparsely and finely punctate without a sign of medial line. *Scutellum* triangular. *Elytra* of same width as prothorax at base, subparallel for the greater part, rather bluntly rounded at apex, lateral border very narrow; striate-punctate, each with eight striae, besides a short scutellary one containing close, moderately large punctures, intervals convex and impunctate; the suture bright green, the two adjacent intervals purple, the next three dark green, the lateral three purple, coppery and bright green respectively. Underside minutely and faintly punctate.

Dimensions: 6-6.5 × 2-2.3 mm.

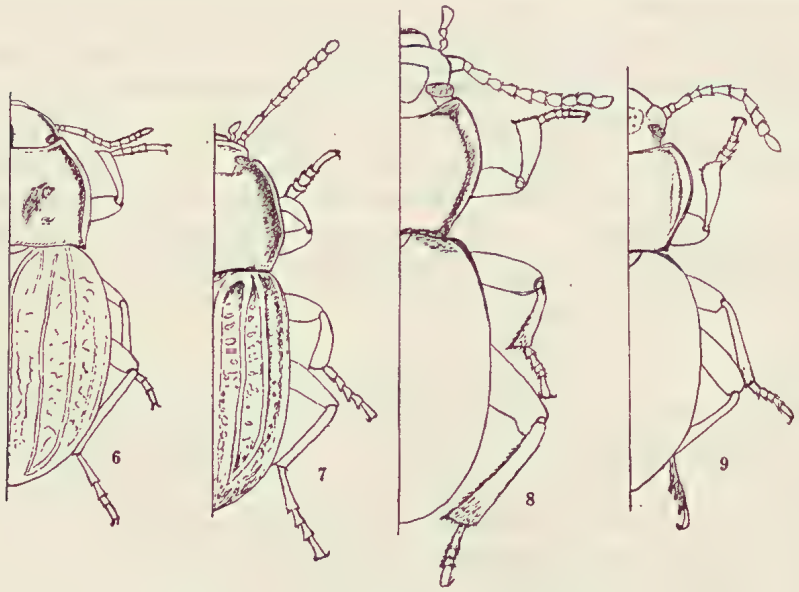
Habitat.—Queensland: Cairns district (Dr. J. F. Illingworth).

Two examples sent by Dr. Illingworth to the Imperial Bureau of Entomology were presented to the British Museum. The species is near *C. cupripennis* Pasc., and may be only a geographical race of that species. Mr. K. G. Blair has kindly compared it with Pascoe's species and notes the following differences:—

C. cupripennis Pasc.	*C. varipennis* Cart.
Antennae and tarsi dark.	Bright red.
Elytra feebly striate, interstices nearly flat.	Strongly striate, punctures much deeper and stronger.
Colours not longitudinally arranged, humeral and apical areas reddish-coppery, suture green, median area mainly brassy.	*Colours* in marked longitudinal bands.

Type in British Museum.

Chariothes (*Menephilus*) *brevis* Cart.—I concur with Mr. Blair's opinion that this species should be transferred to *Chariothes*. It differs from *C. varipennis* in having more brightly coloured elytra, produced anterior angles to prothorax, the margins narrowly but clearly foliate, disc densely and strongly punctate, elytral intervals flat *inter alia*.



Text-fig. 6. *Nyctozoilus lateralis*, n. sp.
Text-fig. 7. *Byallius angustatus*, n. sp.
Text-fig. 8. *Cardiothorax hopsoni*, n. sp.
Text-fig. 9. *Cardiothorax harrisoni*, n. sp.

CARDIOTHORAX HOPSONI, n. sp. Text-fig. 8.

♂. Elongate-ovate, nitid dark bronze above, black beneath, antennae and tarsi reddish.

Head: Epistoma arcuate (concave) in front, subsinuate at sides, antennal orbits rather tumid, frontal impression deep and scutate, its central area raised, antennae stout, gradually widening outwards. *Prothorax* elongate, widest in front of middle, apex arcuate, anterior angles prominent and rather acute, sides moderately rounded, converging rather strongly and sinuate before the posterior angles, these subrectangular, with a short blunt tooth produced backward, base slightly arcuate, this emphasized by the produced angles; foliate margins moderately wide on apical half, strongly narrowing to base, without separating sulcus or setae; disc with a clean-cut medial channel, a light transverse depression near base and posterior angles. *Scutellum* smooth, oval. *Elytra* widely ovate, wider than prothorax at base, epipleural fold evident but not prominent, humeri obliquely rounded off, elytra striate (or sulcate) punctate, fine and rather close punctures clearly visible in the deep striae, intervals 3 and 5 wider than rest and moderately convex on disc, becoming more strongly so near apex; epipleurae and underside impunctate; the hind femora with a strong blunt tooth directed inwards; mid-femora swollen and sub-dentate, hind tibiae moderately enlarged and flattened.

♀. Without these special femoral and tibial characters.

Dimensions: ♂, 21 × 7.3 mm.; ♀, 19 × 7 (+) mm.

Habitat.—New South Wales: Barrington Tops (Mr. John Hopson).

Three examples were taken by Mr. Hopson, the well known pioneer and naturalist of the district, in Fagus brush on the nine-mile spur of the plateau, of which two (the sexes) are under observation, the third being snapped up by a tame magpie.

It is a large species that combines to some extent the sexual characters of *femoratus* Bates and the *walckenaeri* Hope group, with a posterior emargination to the prothorax that is unlike any other, though approaching Hope's species. The distinct seriate punctures on the elytra is a very rare feature in the genus.

Type in Coll. Carter.

CARDIOTHORAX HARRISONI, n. sp. Text-fig. 9.

Elongate-ovate, convex, very nitid bronze above, black beneath, antennae and tarsi piceous.

Head: Epistoma rather bluntly pointed and reflexed in front, its sides oblique, frontal impression rather small, foveate within (in some examples impressed as if by a cloven hoof); antennae less stout than usual, lightly enlarged outwards. *Prothorax* 4 × 5 mm., widest near middle, apex arcuate, anterior angles rather sharply subrectangular, sides moderately widely and evenly rounded, a feeble sinuation near the very small posterior tooth (this little more than a slight production of the border, downward and obliquely outward), base subtruncate; foliate margins horizontal and moderately wide, bearing two to three distinct setae, with a short sulcus separating it from disc, extreme border finely reflexed. *Scutellum* large, oval, convex and smooth. *Elytra*: Shoulders little defined and obliquely rounded; sulcate, with six well marked sulci on disc, the seventh and sometimes the eighth visible on sides; intervals sub-depressed; epipleurae and underside smooth and impunctate.

Dimensions: 15-16.5 × 5.5-6 mm.

Habitat.—New South Wales: Barrington Tops.

Six examples taken by the University expedition of January, 1925, in the Eucalyptus country near the Bull's Head Crossing. The sexual characters are not well defined, shown chiefly by the enlarged tarsi and widened apices of front tibiae and the slightly curved under margin of hind tibiae of the male. The species is nearest to *C. macleayensis* Cart., from which it differs in larger size, more convex form and different elytral sculpture, *macleayensis* having only five clearly marked sulci on each elytron, with more convex intervals, also with larger and more outwardly directed hind angles to prothorax.

Type in the Macleay Museum.

ADELIUM SUB-LAEVIGATUM, n. sp.

Widely ovate; sub-opaque black above, nitid black beneath; antennae and tarsi reddish-brown.

Head sub-laevigate (clypeus sparsely and minutely punctate), the clypeal suture strongly impressed, a frontal triangular impression based thereon, antennal segments sub-conic, 3 as long as 4-5 combined. *Prothorax* rather flat, widest behind middle; sub-laevigate, the only evident sculpture consisting of (1) a feebly impressed medial line near basal half, not extending to base, (2) some undefined depressions separating foliation from disc, (3) a small deep fovea on each side placed on this depression behind the middle, (4) a few minute, shallow punctures on disc. All angles obtuse, the posterior the more widely so; sides widely rounded, with a thin reflexed edge; feebly sinuate before the hind angles; base sub-

truncate, the hind angles produced a little backward. *Scutellum* semicircular. *Elytra*: Shoulders widely rounded; striate-foveate-reticulate, the striae near suture almost entire (without transverse septa), the elongate reticulations more defined and short towards sides. Underside glabrous and laevigate, except for lateral foveae of abdomen, and the epipleurae with shallow punctures.

Dimensions: 15 × 7 mm.

Habitat.—Queensland: Byfield, near Yeppoon (H. J. Carter).

A single example taken under dead boughs, belongs by its elytral sculpture to the *geminatum-reticulatum* group, but differs from all described species thereof by the opaque black, sub-laevigate surface of its pronotum and the non-dentate posterior angles; in the latter character resembling *A. plicigerum* Pasc.

Type in Coll. Carter.

Seirotrana anomala, n. sp.

Oblong-ovate, depressed, bright bronze above, darker bronze beneath, apices of femora testaceous, tarsi reddish, antennae piceous.

Head densely rugose-punctate; antennae submoniliform, gradually widening to apex, 3 not much longer than 4, 11 elongate-oval. *Prothorax* 3 × 4 mm., arcuate-emarginate at apex, anterior angles rather widely acute (apex slightly blunted), base subtruncate, sides moderately rounded on anterior three-quarters, then rather strongly sinuately incurved to the rectangular posterior angles, extreme margins finely, irregularly crenulate (in two out of nine examples this crenulation sub-obsolete); disc densely and rather coarsely punctate with larger punctures irregularly and sparsely placed; without distinct medial line, but foveate depression generally indicating its position near base. *Scutellum* transversely punctate. *Elytra* wider than prothorax at base, humeri rather squarely rounded; seriate-punctate (the seriate punctures smaller and more distant than in *S. parallela* Germ.), the 5th, 7th and 9th intervals having rows of elongate, shining nodules, other intervals containing minute round nodules, all intervals impunctate, suture flat throughout. Episterna and epipleurae coarsely punctate, rest of underside very finely so.

Dimensions: 10-12 × 4.5-5 mm.

Habitat.—New South Wales: Barrington Tops.

Var.—Three examples of the nine before me (of which one is from Eccleston, Allyn River) have the femora concolorous with the general surface; but are without any other distinction. I can find no sexual distinction in the structure.

Six examples of the typical form and two of the variety were taken by the University expedition, generally under dead Eucalyptus boughs lying on the ground. The species is exceptional in having the crenulate sides of prothorax of my Group i, with the punctured disc with larger punctures interspersed of Group ii. It is more naturally allied to *geniculata* Haag. and *femoralis* Macl., from which it can be distinguished by the pronotal sculpture alone.

Type in Macleay Museum.

Seirotrana carbo, n. sp.

Elongate-ovate, depressed, dull black above, nitid black beneath, tarsi and apical segments of antennae piceous.

Head coarsely rugose-punctate on forehead, clypeal area punctate only; antennae rather stout, 3rd segment about 1½ times as long as 4th; 8th-11th oval and successively widening, 11th longer than 10th. *Prothorax* 3 × 4 mm., circularly emarginate at apex, anterior angles acute, base subtruncate (with a wide, shallow

"bay" in the middle), sides lightly rounded, widest at middle, extreme border subcrenulate, with some feeble irregularities on posterior half; a wide shallow concavity preceding the obtuse hind angles; disc closely and finely longitudinally strigose-punctate; medial channel well defined throughout in one example (♂); less defined in the second (? ♀). *Scutellum* transverse, oval. *Elytra* wider than the prothorax at base, humeral angles a little rounded but defined. Seriate-punctate, with rows of large round punctures, intervals finely punctate, the 3rd, 5th, 7th and 9th having rows of elongate, shining studs, becoming sharply raised towards the sides; the alternate intervals with small, feebly indicated nodules; the suture itself irregularly raised. Episterna and epipleurae with large, sparse punctures, the first three segments of abdomen finely but deeply, longitudinally strigose.

Dimensions: 12 × 5 mm.

Habitat.—Queensland: Byfield (H. J. Carter).

Two examples (I think the sexes) were taken under dead Eucalyptus boughs. The species belongs to my first group, having the pronotum laterally crenulate, disc regularly vermiculate-punctate, without larger punctures interspersed. In this group it would come near *catenulata* by colour; but is readily separated from that species by the smaller size, the pronotum with less widened sides and much more finely sculptured disc *inter multa alia.*

Type in Coll. Carter.

Since tabulating the genus *Seirotrana* in 1908, new species have been added, while other modifications of the table are desirable, though I find it difficult to separate some of the species in the few words convenient for such tabulation. The following table may now replace the former one. *S. mastersi* Pasc. and *S. monticola* Blackb. are now transferred to Group ii. With more material I find that these can scarcely be said to have crenulate margins to the pronotum, though a slight irregularity can be seen in some examples, while both have the dual system of puncturation noted for Group ii. *S. orphana* Pasc., as with *S. repanda* Pasc., was described as an *Adelium* but clearly belongs to this genus. *S. foliata* Carter = *Adelodemus squalidus* Macl. and must be placed as a synonym. I was deceived by the small size and abraded clothing of the unique example, which exposed the elytral sculpture to an unusual extent, while the post tarsi were wanting.

Table of *Seirotrana.*

Group i. Sides of pronotum crenulate.

1. Disc of pronotum vermiculate or strigose-punctate without larger punctures interspersed 2
   Disc of pronotum densely punctate with larger punctures interspersed *anomala* Cart.
   Disc of pronotum nodulose ..... *crenicollis* Pasc. var. *denticollis* Cart.
   Disc of pronotum with wide longitudinal sulcus ..... *nosodermoides* Pasc.
2. Elytra with all intervals costate and crenulate ..... *strigipennis* Bates
   Elytra with alternate intervals catenulate 3
3. Femora yellow at apex 4
   Femora unicolorous 5
4. Colour black, or nearly so ..... *geniculata* Haag.
   Colour bright copper, size much smaller ..... *femoralis* Macl.
5. Size large (more than 15 mm. long) ..... *major* Blackb.
   Size smaller (less than 15 mm. long) 6
6. Colour black 7
   Colour bronze 8
7. Pronotum coarsely rugose-punctate, sides strongly crenulate .... *catenulata* Boisd.
   Pronotum finely strigose-punctate, sides feebly crenulate ..... *carbo*, n. sp.

8. Non-catenulate intervals of elytra bearing small granules 9
   Non-catenulate intervals without such granules ..... *vicina* Cart.
9. Elytral intervals, at least on basal half, with transverse septa .. *sub-cancellata* Cart.
   Elytral intervals without transverse septa 10
10. Colour dark bronze, suture not, or scarcely nodulose 11
    Colour coppery-bronze, suture strongly nodulose ..... *vertebralis* Cart.
11. Seriate punctures of elytra large ..... *proxima* Pasc.
    Seriate punctures of elytra smaller ..... *minor* Cart.

Group ii. Sides of pronotum entire; disc generally finely punctate with larger punctures interspersed.

1. Elytra having alternate intervals catenulate 2
   Elytra without raised, nitid, elongate nodules 10
2. Elytral nodules conspicuously raised 3
   Elytral nodules inconspicuous 6
3. Size large (more than 15 mm. long) ..... *mastersi* Pasc.
   Size smaller (less than 15 mm. long) 4
4. Elytral nodules longitudinal 5
   Elytral nodules irregular and oblique ..... *nodicauda* Cart.
5. Narrow and parallel, seriate punctures large ..... *parallela* Germ.
   Ovate, seriate punctures small ..... *bimetallica* Cart.
6. Colour bronze, nodules not confined to apical area 7
   Colour black, nodules only apparent near apex ..... *simplex* Blackb.
7. Elongate sub-parallel, seriate punctures large 8
   Ovate, seriate, punctures small 9
8. Ground punctures of pronotum very fine ..... *elongata* Erichs.
   Ground punctures of pronotum not very fine ..... *integricollis* Haag.
9. Form short and wide, colour coppery ..... *repanda* Pasc.
   Form more elongate, colour dark bronze ..... *monticola* Blackb.
10. Intervals of elytra flat 11
    Intervals of elytra convex 13
11. Size large (more than 15 mm. long) ..... *punctifera* Macl.
    Size small (10-12 mm. long) 12
12. Elytral intervals with minute pustules ..... *simsoni* Cart.
    Elytral intervals impustulate ..... *orphana* Pasc.
13. Colour bronze, alternate intervals interrupted by punctures ..... *tumulosa* Cart.
    Colour black, elytral intervals uniform ..... *uniformis* Cart.

Brycopia quadraticollis, n. sp.

Elongate, narrowly ovate, bright bronze, glabrous and very nitid; antennae and tarsi pale red, legs darker red.

Head very minutely punctate, eyes prominent, antennae moniliform, except the subcylindric 3rd segment, 8th-11th successively wider, 11th oval, much larger than 10th. *Prothorax* nearly square (2 mm. long), slightly wider than long, apex lightly arcuate, anterior angles feebly advanced and obtusely rounded; sides subparallel for the greater part, feebly narrowed at apex; base truncate, posterior angles rectangular, without foliate margins, a very narrow horizontal border visible; disc minutely and sparsely punctate, without medial line or evident foveae. *Scutellum* equiangular triangular. *Elytra* of same width as prothorax at base, shoulders obsolete, sides subparallel; striate-punctate, the punctures in striae round and regular, closer and larger near suture, smaller and more distant towards sides; intervals flat with some minute sparse punctures. Underside minutely and sparsely punctate.

Dimensions: 6 × 2 (+) mm.

Habitat.—New South Wales: Barrington Tops (H. J. Carter).

I took a single example in rotten Eucalyptus wood at an altitude of 5,000 ft. It is very distinct in its cylindric form and nitid surface from any of its congeners.

In my tabulation (Proc. Linn. Soc. N.S.W., 1920, p. 247) it would come next to *minor* Cart., thus:—

30a. Sides of prothorax subparallel ..... *B. quadraticollis*, n. sp.
Type in Macleay Museum.

Cistelidae.

Chromomoea eleanora, n. sp.

Elongate, subparallel, metallic-black above, nitid black beneath, oral organs, tibiae and tarsi (sometimes femora also) testaceous (becoming red in older specimens), three apical joints of antennae, also tarsal lamellae, infuscate.

Head densely striolate-punctate; antennae lineate, 3-10 successively shorter and slightly wider, 11 shorter and narrower than 10. *Prothorax* of same width as head, about as long as wide, base and apex truncate, sides slightly obliquely widened from apex to base, and a little rounded at apex, disc closely and finely punctate, a medial line indicated near base, bisecting a large basal depression, a transverse sulcus parallel and close to base. *Scutellum* transversely oval. *Elytra* wider than prothorax at base and three and a half times as long, shoulders squarely rounded, sides nearly parallel for the greater part; striate-punctate, the punctures largely hidden in the deep sulci, intervals widely convex, densely transversely wrinkled or strigose-punctate, a sparse tomentum visible on apical area. Underside finely punctate and glabrous; legs unarmed in both sexes.

Dimensions: 10-11 x 3 mm.

Habitat.—New South Wales: Barrington Tops. Four examples examined, one taken by myself, December, 1915, the others taken by the University Expedition, January, 1925.

Except *C. violacea* Cart., from the same district and the following species this is the largest of the genus, and differs from *C. rufescens* Bates in colour and sculpture, the latter being much finer in Bates's species (of which I possess a cotype). From *violacea* it differs in size, colour and in the shorter and wider prothorax, which is unusually wide for the genus, but I am unwilling to erect a new genus on this character alone, since in other respects it is a typical *Chromomoea*. I name it in honour of Miss Eleanor Chase, lecturer in Zoology in the University of Sydney, an active collector of the expedition.

Type in the Macleay Museum.

Chromomoea oculata, n. sp.

Elongate; parallel, red or castaneous, underside and appendages testaceous, mandibles infuscate.

Head and pronotum very finely and sparsely punctate, eyes unusually large and prominent, invading the frontal area, the interspace between eyes less than the transverse diameter of one eye, as seen from above; antennae narrowly lineate, segments less enlarged than in *rufescens* Bates, *violacea* or *eleanora*, in length intermediate between the shorter segments of *rufescens* and the longer of *eleanora*, the 11th equal in length to the 10th. *Prothorax* subcylindric, slightly longer than wide, truncate at apex and base, anterior angles rounded, posterior sharply rectangular, medial channel shown for the greater part, but not continued to apex and lying in two longitudinal depressions, one basal, the other pre-apical; a transverse fovea near posterior angles. *Scutellum* triangular. *Elytra* considerably wider than prothorax, humeri prominent and squarely rounded, sides parallel for the greater part, apices separately and sharply rounded; striate-

punctate, punctures in striae very close; intervals equal and regularly convex, sharply so on apical third, finely and sparsely punctate, not wrinkled. Prosternum punctate, elsewhere laevigate and nitid. Legs unarmed in both sexes.

Dimensions: 10-12 × 2½-3 (+) mm.

Habitat.—South Queensland: Tambourine Mountain (H. J. Carter).

I took four examples, including the sexes, by beating foliage in November, 1924. One of these, apparently more mature than the others, is a darker red in colour. It is distinguished from *C. rufescens* Bates by its much larger eyes as well as by its much finer and sparser surface punctures, the elytra without transverse striolation.

Type in Coll. Carter.

GASTEROMYCETES OF AUSTRALASIA.

ii. A Revision of the Genus Tulostoma.

By G. H. Cunningham, Mycologist, Dept. of Agriculture, Wellington, N.Z.

(Plates xxxiii-xxxv.)

[Read 29th July, 1925.]

This paper is the second of a series dealing with the genera and species of the Australian and New Zealand Gasteromycetes. It is the intention of the writer to deal with all genera and species of this sub-class, revising the descriptions and presenting photographs when available, together with micro-photographs of salient microscopic characters. In addition it is intended to work out the development of one or more species of each genus (when material is available), and finally to rearrange the whole according to a modern system of classification. When completed, all these papers will be issued in book form. The author will gladly receive material for description and determination, especially any showing developmental stages of different species and genera of Gasteromycetes. Dr. J. B. Cleland, The University, Adelaide, has very generously lent the whole of his extensive collections, comprising more material than exists in the whole of the other herbaria of Australasia.

Members of the genus *Tulostoma* are found in practically every country throughout the world, but are most abundant in hot and sandy regions. They are characterized by the stipitate, two-layered peridium, which dehisces by an apical orifice, the long, frequently branched, septate capillitium and the coloured, continuous spores. They are usually found with the peridium alone projecting above the surface of the sand or other substratum in which they grow. This makes them difficult to observe, as owing to their inconspicuous colour they are readily overlooked. Immature plants are buried 5-6 cm. or more beneath the surface, and may be obtained only by careful examination of the soil in the vicinity of mature plants.

Structure of the Mature Plant.

Peridium.—This consists of two layers, an exoperidium and an endoperidium. The exoperidium is usually fugacious, soon falling away, save at the base, where it persists as a thick toughened membrane enclosing the endoperidium in a cupulate structure. The former is perforated by the stipe, to which it may occasionally be attached, but usually it is free. In structure the exoperidium consists of somewhat loosely woven hyphae in which are embedded numerous particles of sand, earth or vegetable matter, according to the substratum in which the plant may happen to be growing. Occasionally it does not fall away, but persists as an investment surrounding the endoperidium; this was the principal character upon which was erected the species *T. adhaerens* Lloyd. In other species it is partly adherent, then giving a shaggy appearance

to the specimen by reason of the irregular appearance of the adhering particles, or it may consist of hyphae woven into little projections, which persist and give to the whole plant a verrucose appearance.

The endoperidium is in the nature of a thin, tough, papyraceous membrane enclosing the gleba; it is apically perforated by the so-called mouth, and basally attached to the stipe but separable from it. It consists of an outer intricately woven layer of hyphae of a diameter about half that of the capillitial threads. These hyphae are freely septate, hyaline, and not swollen at the septa. They may be somewhat even, when the endoperidium appears smooth, or may extend for some little distance as free hyphae, giving to the whole peridium a strongly sulcate or fibrillose appearance. Enclosed within this is a second thin layer of pseudoparenchymatous tissue, the cells of which are more or less isodiametric, and it is this layer which gives the endoperidium its toughness. Inside this second layer is a third arising directly from it, and from the free ends of the hyphae of which it is composed arise the threads of the capillitium.

The gleba consists of copious capillitial threads immixed with the abundant spores. The capillitium consists of very numerous long, branched, scantily septate threads. They are usually colourless, but may appear tinted, especially at the septa. The septa may be swollen to about twice the normal thickness, or not, and swollen and non-swollen septa are not infrequent in the same specimen. The ultimate branchlets are thinner than the main branches, and are rounded at their free ends. The spores are usually globose or subglobose, and average about 5 μ in diameter. They are all some shade of brown, and the epispore may be rough or smooth.

The spores are borne on clavate or cylindrical basidia, but instead of being produced apically, as is usual in the Gasteromycetes, they are borne laterally on short sterigmata. Frequently the sterigmata are detached with the spores and remain attached to them, when the spores are said to be "pedicellate" or "apiculate." It is extremely difficult to obtain basidia in other than very immature plants, for spore production is well advanced ere the plants appear on the surface.

Mouth.—This differs in certain species so that it serves as a good group character. Three distinct types may be recognized:—

(1) A circular, definite, erumpent-tubular mouth, characteristic of the type of the genus, *T. brumale.* Sometimes in this group the mouth is not circular, but elliptical and almost plane; this condition may arise as a result of weathering, for it is most frequently met with in old and weathered specimens.

(2) A definite, circular, umbonate mouth surrounded by a layer of hyphae arranged radially around it. This type is said to be fibrillose. In old specimens the fibrils frequently disappear, when the mouth is seen to resemble closely the first type.

(3) An indefinite plane or erumpent aperture. The orifice in this group appears simply as a rupture in the apex of the endoperidium.

(4) Other types of mouths are known. For example a species found in Brazil, *T. exasperatum,* has a raised mouth so resembling those termed fimbriate in the genus *Geaster,* etc., as to have this name applied to it.

Finally Lloyd (1906) mentions a group which may have several mouths in the same endoperidium. The writer has not seen any specimens he would consider to belong to this group.

Stipe.—This varies greatly in length and breadth, even in specimens of the same collection. It consists of an outer cortex, which is usually deciduous, and

an inner stipe proper, composed of pseudoparenchymatous tissue. The stipe is hollow and is invariably filled with a fibrous tissue, hence it is said to be "stuffed". The cortex usually falls away more or less completely, but may persist in the form of coarse scales, as in *T. australianum*. When it falls completely away the stipe is usually smooth, in which condition it often exhibits longitudinal striae. The colour varies according to age, but is by no means constant, even in the same collection. At the base is usually present a bulbous structure which may be hard and woody like the stem, or may consist solely of loosely interwoven mycelial tissue. This structure varies greatly in size and shape, and so is of slight importance to the systematist.

Systematic Position of the Genus.

In the most recent work (Fischer, 1900) the genus is placed in the family Tulostomataceae of the order Plectobasidiineae, containing the four genera *Tulostoma, Queletia, Battarrea* and *Sphaericeps*. Discussion on its true phylogenetic position will be deferred until such time as other related genera have been dealt with, and until certain details of development have been worked out.

Owing to the difficulty of procuring developmental stages, the life-cycle and development of any member of the genus has yet to be worked out. Bessey (1887) mentions the fact that the gleba matures underground, elongation of the stipe commencing only after this has been effected.

Schroeter (1887) has studied the development of spores and basidia in *T. brumale*, and was the first to point out that the spores were borne laterally on a basidium which, in this particular, resembles that of certain of the Uredinales, save that it is continuous, and not septate. No other work appears to have been undertaken with reference to development of members of the genus.

Specific Characters.

Some sixty species have been described; of these twenty have been recorded from Australia, but it is doubtful whether many of these are species, or merely forms of already described species.

Considerable confusion exists in the delimitation of species, and by certain workers the genus is considered to be the most difficult of any included in the Gasteromycetes. The writer believes this confusion to have arisen through the authors of various species fixing upon variable characters, such as shape, size and colour of the peridium, length and colour of the stipe, and degree of septation of the capillitium.

He has recently made a critical examination of some 200 plants of the species *T. poculatum* (the only species found in abundance in New Zealand), and has found that the peridium varies in size from 2 to 12 mm.; it may be perfectly smooth, or more or less covered with the adhering exoperidium; or may be pitted as in the so-called species *T. punctatum* Peck; it may be dingy white or dark brown in colour; and this colour may be spread over the whole peridium, or confined to a portion only. Each of these variations, supposing extremes only were examined, is sufficient to erect a "species" upon. That numerous species have been erected on such flimsy characters is very evident when the literature dealing with the genus is consulted. Owing to this variability it would be unwise to continue to erect species upon colour, roughness or otherwise of the peridium, or even upon size (unless very marked), for this too is by no means constant.

The difficulty is to decide what are fixed characters in such a variable genus; about half of the species which have been described to date cannot be separated on any recognizable character. Recently the writer has worked over various collections of this genus collected in Australia, Tasmania and New Zealand, endeavouring to arrange and describe the collections in such a manner that they would be readily recognized. When arranged according to the older ideas of classification, hopeless chaos resulted; mouth characters were sufficient to split the whole of the collections into three or four groups; drawings and photomicrographs of the capillitium of some ten species were compared, but no one species showed characters not present in others to a greater or less extent.

Finally all collections were treated as unknowns, and certain spore characters alone considered, when it was found possible to separate all into definite groups, as is shown in the artificial key. It became, then, a relatively simple matter to subdivide these groups by mouth characters, colour of the peridium, etc. Spore markings are the most constant of all characters present in the genus, being the least variable; they may readily be defined, and may equally readily be illustrated.

The writer finds that possession of a good equipment is a necessity if reliable results are to be obtained. Personally he uses apochromatic objectives, and does not hesitate to use the oil immersion when in doubt as to the markings on any spores. When apochromats are used good results cannot be expected unless a good condenser is used—the Abbé pattern is worthless for critical work. In addition, attention must be paid to proper correction for cover slip thickness and refractive index of the mountant, for these objectives are hypersensitive in this direction.

For temporary mounts the most suitable medium the writer has used is lactic acid solution, 50% acid in water. Spores are placed in this and heated to nearly boiling point of the solution, when all markings are readily seen, and pseudo-markings (such as folds due to shrinkage) disappear. For critical observations under the oil immersion, canada balsam mounts are desirable.

* Tulostoma Persoon.

Syn. Fungi, 1801, p. 139.—*Tylostoma* de Toni, Sacc. *Syll. Fung.*, vii, 1888, p. 60.

Peridium stipitate, globose to depressed-globose; consisting of an outer thin, usually fugacious exoperidium, and a thin, membranous, coloured or colourless, smooth or rough endoperidium; dehiscing by an apical orifice or mouth, which may be definite or indefinite, naked or fibrillose, erumpent-tubular, umbonate or plane.

Stipe inserted in a "socket" at base of endoperidium to which it is attached; woody, smooth or scaly, striate or not, concolorous throughout, stuffed; usually with a mycelial bulb at base.

Gleba of capillitium and spores, without sterile veins. Capillitium copious, consisting of numerous tinted or hyaline, very long, usually branched threads attached to the endoperidium, septate or not, septa inflated or not. Spores coloured, globose or subglobose, seldom angular, smooth or variously roughened.

Habitat.—Solitary, gregarious or caespitose on ground or more rarely on decaying wood.

Distribution.—World-wide; most plentiful in warm and sandy regions.

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* *Tulostoma*: This was the original spelling used by Persoon, and later by Fries. In *Sylloge Fungorum*, it was by de Toni arbitrarily changed to *Tylostoma*. This is contrary to the International Rules of Nomenclature, so the original spelling of the word must be retained.

Species may be divided into groups according to the mouth characters, but the writer has found it more convenient to make the initial division on spore characters, separating on mouth and peridial characters later.

The spores may be divided into three groups, as given in the key; these divisions are relative, but once seen the differences are readily recognized (see photomicrographs of spores).

All descriptions are original, save where otherwise stated, and have been drawn up from material examined by the writer. All photographs are original and have been taken by my friend Mr. H. Drake, of this laboratory. Their uniform excellence assists greatly in the illumination of characters imperfectly described in the specific descriptions.

The writer is indebted to Dr. J. B. Cleland, The University, Adelaide, for the loan of all collections of this genus in his herbarium; to Mr. L. Rodway, Government Botanist, Hobart, and Mr. C. C. Brittlebank, Plant Pathologist, Dept. of Agriculture, Melbourne, for the loan of specimens from their respective herbaria. Finally he would like to record his appreciation of the work undertaken by Mr. C. G. Lloyd, Cincinnati, Ohio. Mr. Lloyd has examined practically every historical specimen in the herbaria of Europe and America, and by the aid of critical notes and copious illustrations, published in his *Mycological Notes*, has succeeded in making clear the characters upon which most of the older species have been based.

Artificial Key to Species.

Spores perfectly smooth ..... 8. *T. poculatum.*
Spores finely but distinctly verruculose.
  Mouth definite, tubular, entire.
    Peridium smooth, or almost so ..... 2. *T. albicans.*
    Peridium pubescent ..... 1. *T. pubescens.*
  Mouth definite, fibrillose ..... 9. *T. minutum.*
Spores strongly verrucose or verrucose-echinulate.
  Mouth definite, tubular, entire.
    Peridium uncoloured (dingy white or pallid tan).
      Peridium smooth.
        Spores under 10 μ ..... 3. *T. McAlpinianum.*
        Spores over 10 μ ..... 4. *T. macrosporum.*
      Peridium rough with adhering exoperidium ..... 5. *T. adhaerens.*
    Peridium coloured.
      Peridium chestnut-brown ..... 6. *T. brumale.*
      Peridium chocolate-brown ..... 7. *T. Purpusii.*
  Mouth definite, fibrillose.
    Spores closely and finely verrucose ..... 10. *T. subfuscum.*
    Spores striate ..... 11. *T. striatum.*
  Mouth indefinite ..... 12. *T. australianum.*

SECTION I: Mouth definite; circular or elliptical, tubular or plane.

a. Spores finely and distinctly verruculose.

1. TULOSTOMA PUBESCENS, n. sp. Plate xxxiii, fig. 1.

Peridium depressed-globose, up to 10 mm. high, 20 mm. diam.; exoperidium persistent, dingy brown, almost black, in the nature of coarse mycelial fibres mixed with vegetable debris; endoperidium ferruginous, pubescent with closely appressed silky threads. Mouth definite, 2.5-3 mm. diam., circular, plane.

Stipe up to 4 cm. × 6 mm., equal, densely pubescent, colour of the peridium, stuffed, rugulose.

Gleba reddish-brown; capillitium hyaline, threads sparingly septate, slightly thicker than the spores, branched, septa plane. Spores globose or subglobose,

4-5.5 μ, apiculate; epispore finely and delicately verruculose, pallid ferruginous, 0.75 μ thick.

Habitat.—Solitary on the ground.

Distribution.—South Australia: Pt. Gawler (Apr., 1923, J. B. Cleland). Type in Herb. Cleland.

It is with some hesitation that the writer has erected this species, for it is based on a single specimen. Nevertheless, the plant is so characteristic that it may readily be recognized. The plane definite mouth, adhering fibrous exoperidium, pubescent endoperidium and stipe are very distinctive, for certain of these characters have been met with only in this specimen. The plant is somewhat damaged, hence the shape of the peridium, as shown in the photograph, is not characteristic.

2. TULOSTOMA ALBICANS White. Plate xxxiii, fig. 2; Pl. xxxv, fig. 19.

Bull. Torrey Bot. Club, vol. 28, 1901, p. 428.

Peridium depressed-globose, up to 10 mm. high, 12 mm. diam.; exoperidium soon falling away from the upper portion but persisting at the base of the endoperidium, which is smooth, thin, papyraceous, dingy-white or pallid-tan. Mouth small, 1 mm. diam., circular, short-tubular, entire.

Stipe 2-4 cm. × 3-6 mm., equal, bay-brown, finely striate, fibrillose, stuffed, with a small mycelial pad at the base.

Gleba reddish-brown; capillitium hyaline or tinted, threads branched, sparsely septate, septa moderately swollen. Spores globose or subglobose, 4-6 μ diam., frequently apiculate; epispore pallid ferruginous, finely and moderately verruculose, 1 μ thick.

Habitat.—Solitary or gregarious on the ground.

Distribution.—North America; Australia.

New South Wales: Dubbo (Oct., 1913. †J.B.C.), *Forbes (Aug., 1915. J.B.C.), Manildra (Oct., 1916. J.B.C.), *Near Barellan (Aug., 1918. J.B.C.), Narrabri (May, 1919. J.B.C.).

South Australia: *Reynella (July, 1914. J.B.C.; *Id.*, Lloyd, No. 80, as *T. McAlpinianum*), **Monarto South (J.B.C.), ***Beaumont, Adelaide (June, 1917. J.B.C.), between sand dunes and Milton Railway Station (Jan., 1920. Prof. Howchin), Berri (Jan., 1921. J.B.C.; *Id.*, Lloyd, No. 750, as *T. simulans*), Beaumont (July, 1921. J.B.C.), 10 miles west Overland Corner (Feb., 1922. J.B.C.), Big Swamp, 12 miles west Port Lincoln (Feb., 1922. J.B.C.), Ooldea (Aug., 1922. J.B.C.), Flinders Range, Pt. Augusta (Aug., 1922. J.B.C.), Mr. Zeitz Coll.

Victoria: Melbourne (June, 1885. F. M. Reader), near Dimboola (July, 1890. F. M. Reader).

Tasmania: Domain, Hobart (Mar., 1920. L. Rodway).

Var. NIGROSTIUM, n. var.

Peridium similar to *T. albicans*, but differing in that the mouth is strongly coloured, usually brown, frequently lead colour. Other characters as above.

Distribution.—New South Wales: Bumberry (Sept., 1916. J.B.C.), The Rock (July, 1917. J.B.C.; *Id.*, Lloyd, No. 382, as *T. albicans*).

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* These forms possess spores more strongly marked than the usual.

** This is a larger and more globose form.

*** Doubtful determination as the mouth is gone.

† J.B.C. = J. B. Cleland.

T. albicans is characterized by the pallid peridium, definite tubular mouth, and especially by the finely verruculose spores.

Lloyd has placed one of these collections under *T. McAlpinianum*, another under *T. simulans* Lloyd, and a third under *T. australianum*. It is difficult to separate *T. McAlpinianum* from this species, other than by the spore markings (see note under this species). In his paper Lloyd (1906) considers *T. simulans* to be a form of *T. mammosum* (*T. brumale*). The characters of this latter are the coloured peridium, darker mouth, freely septate capillitium and strongly verrucose spores. His *T. brevipes* he claims to be an uncoloured form, possessing all other characters; but his *T. simulans* is claimed to have a differently coloured peridium and different capillitium. If so, then it has no relationships with *T. brumale* whatsoever. The specimen so named in the collection from Berri, South Australia, is typically *T. albicans*, and does not differ in any particular, so far as the writer is able to judge.

T. albicans is the most abundant species in Australasia, judging from the collections that have passed through the writer's hands.

b. Spores strongly verrucose or verrucose-echinulate.

3. TULOSTOMA MCALPINIANUM Lloyd. Plate xxxiii, figs. 3, 4.

Tylostomeae, 1906, p. 15. (Emended).

Peridium depressed-globose or globose, up to 12 mm. high, 15 mm. diam.; exoperidium soon falling away from the upper portion, but remaining at the base of the endoperidium as a thickened, closely adherent disc; endoperidium smooth, partly covered with adhering particles of the exoperidium, or slightly pitted, papyraceous, dingy-white or pallid-tan. Mouth small, 1-1.5 mm. diam., circular or elliptical, short-tubular, entire.

Stipe 2-8 cm. × 3-5 mm., equal, slightly or not thickened basally, coloured bay- or chestnut-brown, fibrillose, striate, woody, stuffed.

Gleba reddish-brown; capillitium hyaline or tinted, threads sparingly branched, sparsely septate, septa slightly swollen. Spores globose or subglobose, 5-8 μ diam.; epispore pallid ferruginous, coarsely, bluntly and sparsely verrucose, 1 μ thick.

Habitat.—Solitary or gregarious on the ground.

Distribution.—New South Wales: Narrabri (June, 1918. J.B.C.). South Australia: River Murray, near Morgan (Nov., 1913. J.B.C.), Adelaide (July, 1920. J.B.C.; *Id.*, Lloyd, No. 710, as above), Kinchina (July, 1922. J.B.C.). Victoria: Canterbury (March, 1909. C. French, Jr.), Melton (Sept., 1899. C. French, Jr.).

The writer has found it impossible to separate this species from the preceding, save by the spore markings. It is evident that Lloyd himself is not clear as to the characters of this species, for he states (1906): "While it is very difficult to draw up a diagnosis of the differences between this and *T. albicans*, the plants are not the same and our photograph will show it better than our description can. The plant in general appearance very much resembles *T. mammosum*, but is uncoloured and has almost smooth spores. *T. albicans* belongs to a different type of plants in shape and cortex from *T. mammosum*." Further evidence as to the difficulty Lloyd has had in placing his species, is shown from his determinations of some of Dr. Cleland's specimens. For example, one collection (No. 80) which he has determined as being *T. McAlpinianum*, the writer places under *T. albicans*, for the spores are quite different from those of the collection (No. 710) Lloyd placed under *T. McAlpinianum*. A third collection (No. 79) Lloyd claimed to be this species has spores which are coarsely echinulate and fully twice as large.

In his original description of *T. McAlpinianum*, Lloyd stated that the spores were almost smooth, yet three collections named by him as this species have verrucose spores. Such confusion can occur only when species are erected on such variable characters as colour, shape and markings of the peridium. As three collections with verrucose spores have been determined by Lloyd as being *T. McAlpinianum*, the writer has arbitrarily fixed upon this as being the only character of specific value upon which it may be separated from *T. albicans*, for it is obvious that until some such stand is taken no means exists of determining this species accurately. See also remarks under *T. albicans*.

4. TULOSTOMA MACROSPORUM, n. sp. Plate xxxiii, fig. 5; Pl. xxxv, fig. 20.

Peridium depressed-globose, up to 8 mm. high, 12 mm. diam.; exoperidium completely falling away from the endoperidium, leaving this smooth save at the base; endoperidium white, smooth, thin, papyraceous. Mouth entire, short-tubular, circular, 1 mm. diam.

Stipe 2-3 cm. × 1.5-2 mm., equal, smooth, sparsely striate, woody, stuffed, slightly dilated at the base.

Gleba pallid-violaceous; capillitium tinted or hyaline, threads sparsely branched, septa slightly swollen. Spores globose or subglobose, 9-13 μ diam.; epispore ferruginous, densely and coarsely echinulate, spines about 1 μ long, epispore 1.5-2 μ thick.

Habitat.—Caespitose on the ground.

Distribution.—New South Wales: Dubbo (July, 1915. J.B.C.). Type in Herb. Clel. (*Id.*, Lloyd, No. 79, as *T. McAlpinianum*).

The caespitose habit, violaceous gleba, and especially the large and coarsely echinulate spores, characterize this species. If *T. McAlpinianum* is to be maintained as a species—separable only upon spore markings—then the above also must be considered a distinct and clearly defined species.

5. TULOSTOMA ADHAERENS Lloyd. Plate xxxiii, fig. 6; Pl. xxxiv, fig. 7.
Mycological Notes, vol. 7, 1923, p. 1199.

Peridium depressed-globose, up to 10 mm. high, 15 mm. diam.; exoperidium a firm, closely adhering sand case, bay-brown, rough; endoperidium dark-brown, tough, membranous. Mouth definite, elliptical, about 3 × 1 mm., entire, not or slightly protruding.

Stipe 2-3 cm. × 3-5 mm., fibrillose, ochraceous or bay-brown, woody, stuffed, equal, geniculate, with a slight mycelial bulb at base.

Gleba ochraceous or pallid-ferruginous; capillitium subhyaline, threads branched, slightly swollen at the septa. Spores globose or subglobose, 5-6 μ diam.; epispore pallid-ferruginous, closely and finely verrucose, 0.75 μ thick.

Habitat.—On the ground.

Distribution.—New South Wales: Narrabeen (July, 1916. J.B.C.). Type Coll. in Herb. Clel. (Lloyd, No. 794).

The above description has been drawn up from type collection material kindly donated by Dr. Cleland, and now in my herbarium, No. 2192.

Lloyd states that this is the first collection made in Australia possessing this type of mouth. He places it (1906) in Section 6 defined as "Mouth definite, naked, elongated, sometimes several on the same peridium."

The elongate plane mouth and rough adhering exoperidium characterize the species. As to whether this last feature is constant, or merely a condition due to immaturity of the plants, it is impossible to determine from the material at hand.

6. TULOSTOMA BRUMALE Persoon. Plate xxxiv, fig. 8; Pl. xxxv, fig. 21.

Syn. Meth. Fungi, 1801, p. 139.—*Tulostoma mammosum* Fr., *Syst. Myc.*, vol. 3, 1829, p. 42.—*Tylostoma pedunculatum* Schroet., Cohn, *Beitr. Biol. Pflan.*, vol. 2, 1877, p. 65.

Peridium globose or slightly depressed-globose, up to 12 mm. diam.; exoperidium usually completely falling away from all but the base of the endoperidium, occasionally persisting as irregular, scattered patches; endoperidium papyraceous, chestnut- or bay-brown, smooth. Mouth small, 1-1.5 mm. diam., circular, short-tubular, entire, protruding, darker than the endoperidium.

Stipe 2-4 cm. × 2-4 mm., bay- or reddish-brown, equal, smooth or slightly scaly, sparingly striate, stuffed, with a small mycelial bulb at the base.

Gleba ferruginous; capillitium hyaline, threads branched, somewhat freely septate, septa moderately swollen; spores globose, 4-5 μ diam., frequently apiculate; epispore pallid-ferruginous, moderately and sparsely verrucose, 1 μ thick.

Habitat.—Solitary on the ground.

Distribution.—England; Northern and Central Europe; North America; Australia; New Zealand.

Victoria: Frankston (July, 1905. D. McAlpine; *Id.*, Lloyd, No. 23, as *T. albicans*).

New Zealand: Sandhills, Levin, Wellington (Dec., 1919. E. H. Atkinson).

Lloyd states (1905) that there is one collection of this species from Australia at Kew, collected at White River in 1870, which he believes to be the typical form. On the other hand, he claims that the true form does not occur in North America, and lists (1906) under *T. simile* and *T. rufum* Lloyd, all forms found in that country.

The New Zealand and Australian specimens listed above agree in all particulars with recent descriptions, although some forms approach *T. Purpusii* in the colour of the endoperidium, lending strength to the contention that the latter is better considered as a variety of *T. brumale*. One recent worker (Rea, 1922) describes the spores as being "pinkish". Surely this is an unusual colour for the spores of any species belonging to this genus. If correct, then our form is not the same as the European, as the spores are decidedly ferruginous, and under the microscope, pallid-ferruginous, when viewed with apochromats, which render colour tones correctly.

7. TULOSTOMA PURPUSII P. Hennings. Plate xxxiv, fig. 9.

Hedwigia, vol. 37, 1898, p. 274.

Peridium depressed-globose, up to 15 mm. high, 2 cm. diam.; exoperidium imperfectly falling away from the endoperidium, remaining as small, irregular patches upon the upper surface and firmly attached basally; endoperidium dark-chestnut, chocolate or sepia-coloured, thin, firm, membranous, frequently furfuraceous. Mouth small, 1-2 mm. diam., circular or elliptical, short-tubular, entire, frequently darker in colour.

Stipe 1.5-2 cm. × 3-5 mm., equal, ochraceous or ferruginous, floccose but not scaly, sparsely striate, stuffed, often slightly inflated basally.

Gleba ferruginous; capillitium tinted or hyaline, threads sparingly branched, scantily septate, septa slightly swollen. Spores globose or subglobose, 5-7 μ diam.; epispore pallid-ferruginous, moderately and somewhat closely verrucose, 1 μ thick.

Habitat.—Solitary or caespitose on the ground.

Distribution.—North America; Australia.

New South Wales: Under pine tree, Botanic Gardens, Sydney (June, 1908. E. Cheel; *Id.* by Lloyd as above); specimens in Herb. Cleland. Garden, Neutral Bay, Sydney (Dec., 1919. J.B.C.).

The writer is of the opinion that this is best considered as a large, more deeply coloured form of *T. brumale*, for it is difficult to separate it from this species other than upon these two characters. Lloyd states (1906): "This species can easily be taken for a giant form of *T. mammosum*. It is a rare plant and I have seen from America only the type specimens at Berlin, which were collected in Colorado by a Mr. Purpus. We refer here (for the time at least, rather than make a new species) plants from Australia with the same general characters, but which differ in the more persistent cortex and the spores, which in the Australian species vary from 4 to 7 μ."

SECTION II.—Mouth definite, fibrillose.

a. Spores perfectly smooth.

8. TULOSTOMA POCULATUM White. Plate xxxiv, figs. 10, 11; Pl. xxxv, fig. 22.

Bull. Torrey Bot. Club, vol. 28, 1901, p. 431.

Peridium depressed-globose, up to 10 mm. high, 12 mm. diam.; exoperidium breaking away completely save the persistent basal portion; endoperidium fawn-coloured or dingy-white, smooth, papyraceous. Mouth raised, surrounded by a circular fibrillose zone which may attain a diameter of 3 mm.

Stipe 2-3 cm. × 3-5 mm., tan-coloured, sulcate, striate, equal, stuffed, slightly bulbous at the base.

Gleba ferruginous; capillitium tinted or hyaline, threads sparingly branched, slightly swollen at septa. Spores globose or subglobose, frequently subangular, 4-6 μ diam., apiculate; epispore pallid-ferruginous, perfectly smooth, 0.75 μ thick.

Habitat.—Solitary or gregarious on the ground.

Distribution.—North America; Australia; New Zealand.

New South Wales: Belmore, Sydney (July, 1909. A. A. Hamilton), The Rock (July, 1917. J.B.C.; *Id.*, Lloyd, No. 381, as above), Coolamon (May, 1918. J.B.C.), near Barellan (Aug., 1918. J.B.C.), * Wombeyan Caves (Nov., 1919. J.B.C.).

South Australia: Beaumont, Adelaide (May, 1920. J.B.C.), * Kinchina (July, 1922. J.B.C.).

New Zealand: Sandhills, Levin, Wellington (Nov., 1919. S. A. Cunningham, E. H. Atkinson, G.H.C.; *Id.*, Lloyd, No. 67, as above).

This species is characterized by the pallid, smooth peridium, fibrillose, raised mouth and smooth, apiculate spores. The smooth spores especially are a constant character of all the specimens listed above.

b. Spores finely and distinctly verruculose.

9. TULOSTOMA MINUTUM White.

Bull. Torrey Bot. Club, vol. 28, 1901, p. 430.

Peridium depressed-globose, 0.5-1 cm. high, 1-1.2 cm. diam.; exoperidium dingy-brown, imperfectly breaking away from the upper part of the endoperidium, but remaining at base; endoperidium pallid-chestnut-brown, membranous. Mouth slightly raised, fibrillose, small, 2 mm. diam.

Stipe 1-2 cm. × 2-4 mm., slender, stuffed, brown, striate, frequently with small mycelial pad at base.

* Doubtful determinations; mouths gone, but spores *T. poculatum* type.

Gleba ferruginous; capillitium tinted, threads sparingly branched, septa slightly swollen. Spores globose or subglobose, 4-6 μ diam., apiculate; epispore ferruginous, minutely and closely verruculose, 1 μ thick.

Habitat.—Solitary on the ground.

Distribution.—North America; Australia.

South Australia: Berri (Jan., 1921. J.B.C.), Beaumont, Adelaide (July, 1921. J.B.C.).

These specimens are doubtfully referred to *T. minutum* White. They are too small to be referred to other species possessing fibrillose mouths, with the exception of *T. poculatum*, and differ from this species in the spores being closely and finely verruculose and not smooth.

c. Spores verrucose.

10. Tulostoma subfuscum White. Plate xxxiv, fig. 12; Pl. xxxv, fig. 18.

Bull. Torrey Bot. Club, vol. 28, 1901, p. 433.

Peridium depressed-globose, up to 12 mm. high, 15 mm. diam.; exoperidium dingy-brown, imperfectly breaking away from apical portion, but remaining as a firm membrane at the base of the endoperidium; the latter smooth, varying in colour from bay-brown to dingy-ferruginous, tough, membranous. Mouth raised, minute, surrounded by a scanty fibrillose zone 1-2 mm. diam.

Stipe 2-3 cm. × 2-3 mm., fibrillose or scaly, leathery, dingy-brown, striate, equal, stuffed, with small mycelial bulb at base.

Gleba ferruginous; capillitium hyaline or tinted, threads branched, sparsely septate, slightly thickened at the septa. Spores globose to subglobose, 4-6 μ diam., sometimes apiculate; epispore pallid-ferruginous, finely and moderately verrucose, 0.75 μ thick.

Habitat.—Solitary or gregarious on the ground.

Distribution.—North America; Australia.

New South Wales: Mummulgum (Dec., 1916. J.B.C.; *Id.*, Lloyd, No. 267, as *T. poculatum*).

This species differs from *T. poculatum* in the somewhat larger size, darker colour of the peridium and stipe, smaller and less fibrillose mouth and finely verrucose spores. Lloyd (1906) considers it to be a form only, but it is quite a distinct plant. The colour of the peridium varies from dark-brown (almost chocolate) to bay-brown, but as colour has little specific value, this variation is of little moment.

11. Tulostoma striatum, n.sp. Plate xxxiv, fig. 13; Pl. xxxv, fig. 17.

Peridium depressed-globose, up to 15 mm. high, 20 mm. diam.; exoperidium pallid-tan colour, soon falling away save where persistent at the base, in some specimens persisting as irregular roughened patches; endoperidium pallid-tan or dingy-white, smooth, papyraceous. Mouth raised, irregularly circular, surrounded by a fibrillose zone, up to 3 mm. diam.

Stipe 2-6 cm. × 2-4 mm., equal, pallid-tan, stuffed, striate, slightly enlarged towards the base.

Gleba ferruginous; capillitium hyaline, threads somewhat flattened, branched, sparingly septate, slightly swollen at the septa. Spores globose or subglobose, 4-6 μ diam.; epispore coarsely and sparsely verrucose, verrucae arranged in striae, 1 μ thick.

Habitat.—Solitary or caespitose on the ground.

Distribution.—New South Wales: Forbes (Aug., 1915. J.B.C.; *Id.*, Lloyd, No. 81, as *T. poculatum*). South Australia: Berri (Jan., 1921. J.B.C.; *Id.*,

Lloyd, No. 751, as *T. poculatum*. Type); Ooldea (Aug., 1922. J.B.C., two collections), Unknown locality (J. G. O. Tepper; *Id.*, Lloyd, No. 14, as *T. australianum* . Specimens in Herb. Victorian Dept. Agr.).

This species resembles *T. poculatum* in mouth characters, but is a much larger plant, and in addition possesses verrucose spores. The verrucae are arranged in striae, giving the spores a very characteristic appearance, and it is upon this character that the species is erected. It somewhat resembles the description of *T. tuberculatum* White, but as there is no mention of these peculiar and characteristic spore striae in the description, it is considered to be distinct and so kept separate.

Section III. Mouth indefinite.

12. Tulostoma australianum Lloyd. Plate xxxv, figs. 14-16.

Tylostomeae, 1906, p. 20 (Emended).

Peridium strongly depressed-globose, almost pulvinate, up to 15 mm. high, 24 mm. diam.; exoperidium falling completely away save at the base; endoperidium smooth, dingy-white, tough, thick, membranous. Mouth indefinite, plane, a simple, irregularly torn aperture.

Stipe up to 15 cm. × 6 mm., equal, covered with coarse deciduous scales, markedly striate, woody, stuffed, bay-brown, with a strongly developed woody bulbous base.

Gleba ferruginous; capillitium hyaline, threads branched, moderately swollen at the somewhat sparse septa. Spores globose or subglobose, 4-6 μ diam.; epispore finely and sparsely verrucose, pallid-ferruginous, 0.75 μ thick.

Habitat.—Solitary on the ground.

Distribution.—South Australia: Monarto South (May, 1921. J.B.C. Two collections, both *Id.*, Lloyd, Nos. 792, 781, as above), same locality (Sept., 1921. J.B.C.; *Id.*, Lloyd, No. 793, as above).

This species is characterized by the indefinite plane mouth, scaly stipe and verrucose spores. In his original description Lloyd states that the spores are smooth, and the stipe is not scaly. He further mentions that the species is the most abundant in Australia. "It has a large head and a short stipe, and in general appearance is the same as *T. album* (type specimen at Kew), but it has smooth spores (slightly granular in *T. album*)." Thus his original conception of the species was a plant with a non-scaly stipe and smooth spores. Nevertheless, he has determined no less than three collections of the plant described above as being *T. australianum*. Rather than erect another species, the writer has emended Lloyd's description to include these collections. Lloyd has also determined as *T. australianum* one collection (Dept. Agr. Vic. Coll., No. 14) which the writer places under *T. striatum*. Another the writer places under *T. albicans*.

Lloyd (1906) lists two additional species under this section. As the writer has not seen specimens, he cannot pass an opinion as to their validity, so gives Lloyd's descriptions to enable the student to place them.

Tulostoma Readeri Lloyd.

Tylostomeae, 1906, p. 21.

Peridium uncoloured, firm, white. Cortex of the nature of a sand case, peeling off imperfectly and persistent at the base. Mouth an enlarged torn opening. Stipe long, dark, rough but not scaly, frequently with mycelial fibres. Capillitium hyaline, broad threads. Septa rare with rounded ends and not swollen. Spores 5-6 μ, granular.

This plant has a general resemblance to *T. granulosum*, but has not the same mouth. Species collected by F. M. Reader at Casterton, Australia.

TULOSTOMA EGRANULOSUM Lloyd.
Tylostomeae, 1906, p. 21.

Peridium uncoloured, with an irregular, torn aperture. Cortex as a sand case imperfectly separating, thickened and persistent at the base. The cortex does not separate as freely as most species, but adheres with a "pitted" effect on the peridium. Stipe dark, rigid. Capillitium subhyaline, with rare but swollen nodes. Spores 5-6 μ, granular.

This plant is very close to *T. granulosum* of Europe, but the mouths of these specimens are not furnished with "granular fibrils." Australia: D. McAlpine, F. M. Reader.

In Cooke's *Handbook of Australian Fungi*, 1894, pp. 224-225, the following species are recorded as being found in Australia. Judging from the descriptions, one is led to believe that the whole were compiled from Saccardo's *Sylloge Fungorum*, vol. 7.

a. TULOSTOMA ALBUM Massee, *Grevillea*, vol. 19, 1891, p. 95. Lloyd states (1905) that: "The specimen on which this is based is old, weathered and bleached out. It has a large head and a short thick stalk, but I could not make out its mouth characters." It is therefore impossible to place this species, for in the original description no mention is made of its mouth characters.

b. TULOSTOMA GRANULOSUM Lev., *Demid. Voy.*, Vol. 2, 1842, p. 120, t. iv, fig. 1—*Tulostoma brachypus* Czern., *Bull. Mosc.*, 1845, p. 144.—The description is too inadequate to allow of this species being placed.

c. TULOSTOMA FIMBRIATUM Fr., *Syst. Myc.* vol. 3, 1829, p. 43.—It is probable that this is a misdetermination of *T. poculatum*, for no species with "fimbriate" mouths is known to have been collected in Australia. Lloyd (1905) states that there are specimens at Kew from Swan River so labelled, but he was unable to examine their mouths.

d. TULOSTOMA LEPROSUM Kalchbr., *Grev.*, vol. 4, 1876, p. 72.—This is referred to *T. mammosum* by Kalchbrenner, but is separated on account of the peridium being covered with a "lurid umber mealy scurf." The description is too imperfect to allow of its being recognized.

e. TULOSTOMA MAMMOSUM Fr.—This is a synonym of *T. brumale* Pers. (q.v.).

f. TULOSTOMA MAXIMUM Cooke and Massee, *Grev.*, vol. 15, 1887, p. 94.—Lloyd, who has examined the type at Kew, states that this is a synonym of *Chlamydopus Meyenianus* (Kl.) Lloyd, *Letter*, No. 67, 1918, p. 12.

g. TULOSTOMA PULCHELLUM Saccardo, *Bull. Soc. Myc. Fr.*, vol. 5, 1889, p. 118.—"This species . . . rests on a single little specimen . . . made in Australia by Tepper. While it is not fair to form an opinion of a 'species' on one little specimen, this must form a section by itself. The very short stem is itself a departure from all others and the stem does not appear to be inserted in a socket as in all other true Tylostomas. The colour is now chocolate brown, the surface, under a lens, scurfy. The mouth is simply an indefinite opening. Gleba, rust colour. Spores, unusually large for a Tylostoma, 8-9 μ, globose, pale coloured, smooth [5-6 μ, according to Saccardo]." Lloyd, *Myc. Notes*, vol. 7, 1923, p. 1233.—The species is said to grow upon branches.

h. TULOSTOMA WIGHTII Berkeley, *Hook. Jour. Bot.*, 1842, p. 157.—The species was described from specimens collected in India. No specimens from Australia are at Kew.

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EXPLANATION OF PLATES XXXIII-XXXV.

Plate xxxiii.

1. *Tulostoma pubescens* G. H. Cunn. × 5/4. This plant is much broken and so is not accurately represented in the photograph.
2. *Tulostoma albicans* White. Natural size.
3. *Tulostoma McAlpinianum* Lloyd. Natural size.
4. *Tulostoma McAlpinianum* Lloyd. × 3/2. Peridium, showing structure of the definite, tubular mouth.
5. *Tulostoma macrosporum* G. H. Cunn. Natural size. Note the caespitose habit. Three peridia are joined together in the specimen on the right; the stipes have been broken away.
6. *Tulostoma adhaerens* Lloyd. Natural size.

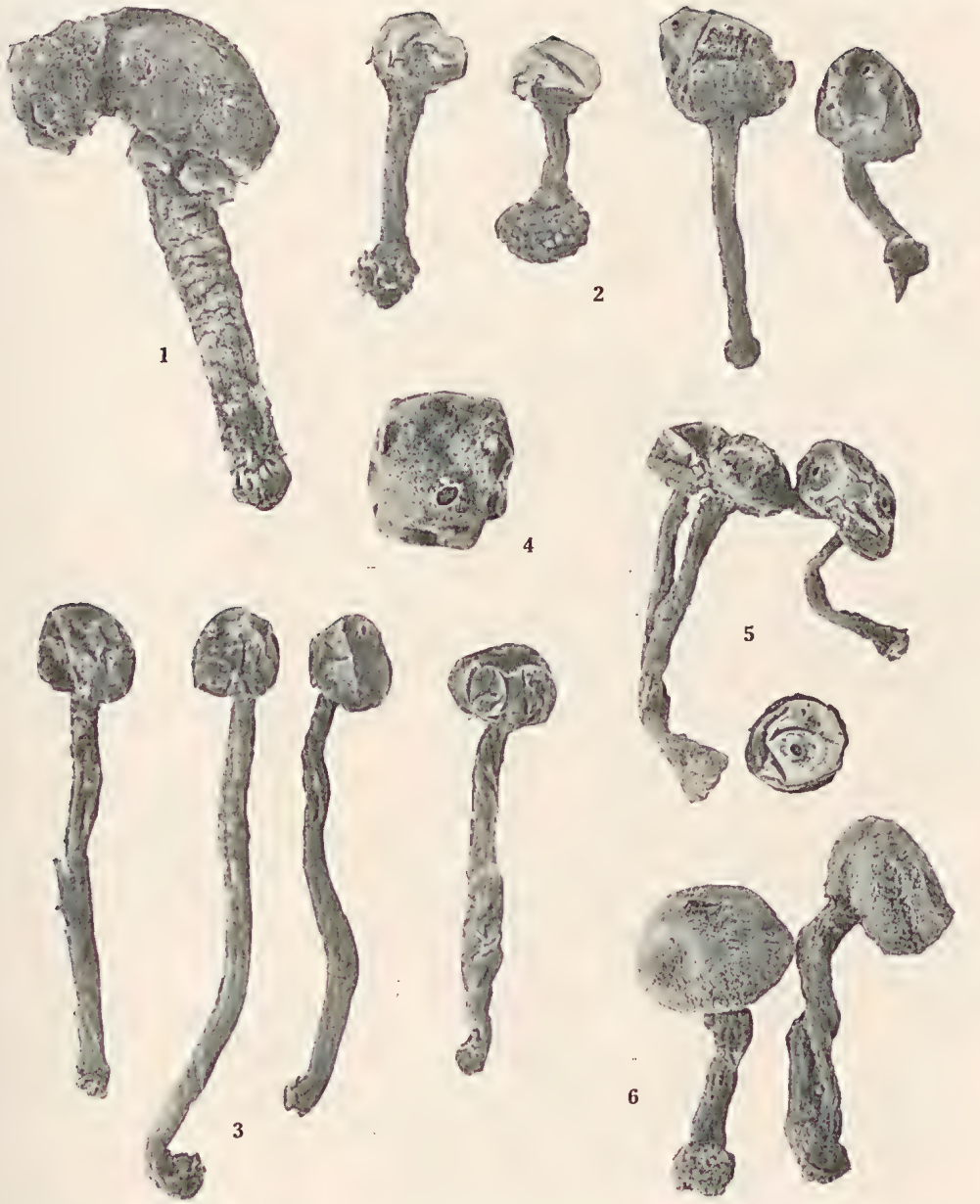
Plate xxxiv.

7. *Tulostoma adhaerens* Lloyd. × 2. Peridium showing definite, elliptical, almost plane mouth.
8. *Tulostoma brumale* Pers. Natural size.
9. *Tulostoma Purpusii* P. Henn. Natural size. Specimen on the right has lost its stipe.
10. *Tulostoma poculatum* White. Natural size. Peridium in centre (lower) is inverted to show stipe socket.
11. *Tulostoma poculatum* White. × 2. Peridia showing fibrillose mouths; weathered specimen on the left.
12. *Tulostoma subfuscum* White. Natural size.
13. *Tulostoma striatum* G. H. Cunn. Natural size.

Plate xxxv.

14. *Tulostoma australianum* Lloyd. × 3/4.
15. *Tulostoma australianum* Lloyd. Natural size.
16. *Tulostoma australianum* Lloyd. × 3/2. Peridium showing the indefinite mouth.
17. *Tulostoma striatum* G. H. Cunn. Spores. Note striae on the surface of the epispore.
18. *Tulostoma subfuscum* White. Spores. Note rounded sparse verrucae on the epispore.
19. *Tulostoma albicans* White. Spores. Note verruculose surface of the epispore.
20. *Tulostoma macrosporum* G. H. Cunn. Spores. Note large size of the spores and their rough surfaces.
21. *Tulostoma brumale* Pers. Spores. Note verrucose nature of the epispore.
22. *Tulostoma poculatum* White. Spores. Note that spores are smooth and irregular in shape.

All photographs were taken by H. Drake. Photomicrographs magnified 540 diam. The photomicrographs were taken with a 4 mm. apochromatic objective, N.A. 0.7, comp. ocular × 10, 200 mm. tube length; Watson's parachromatic condenser, yellow-green screen, filament lamp, × 540, exposure 2 minutes.

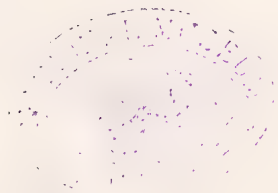


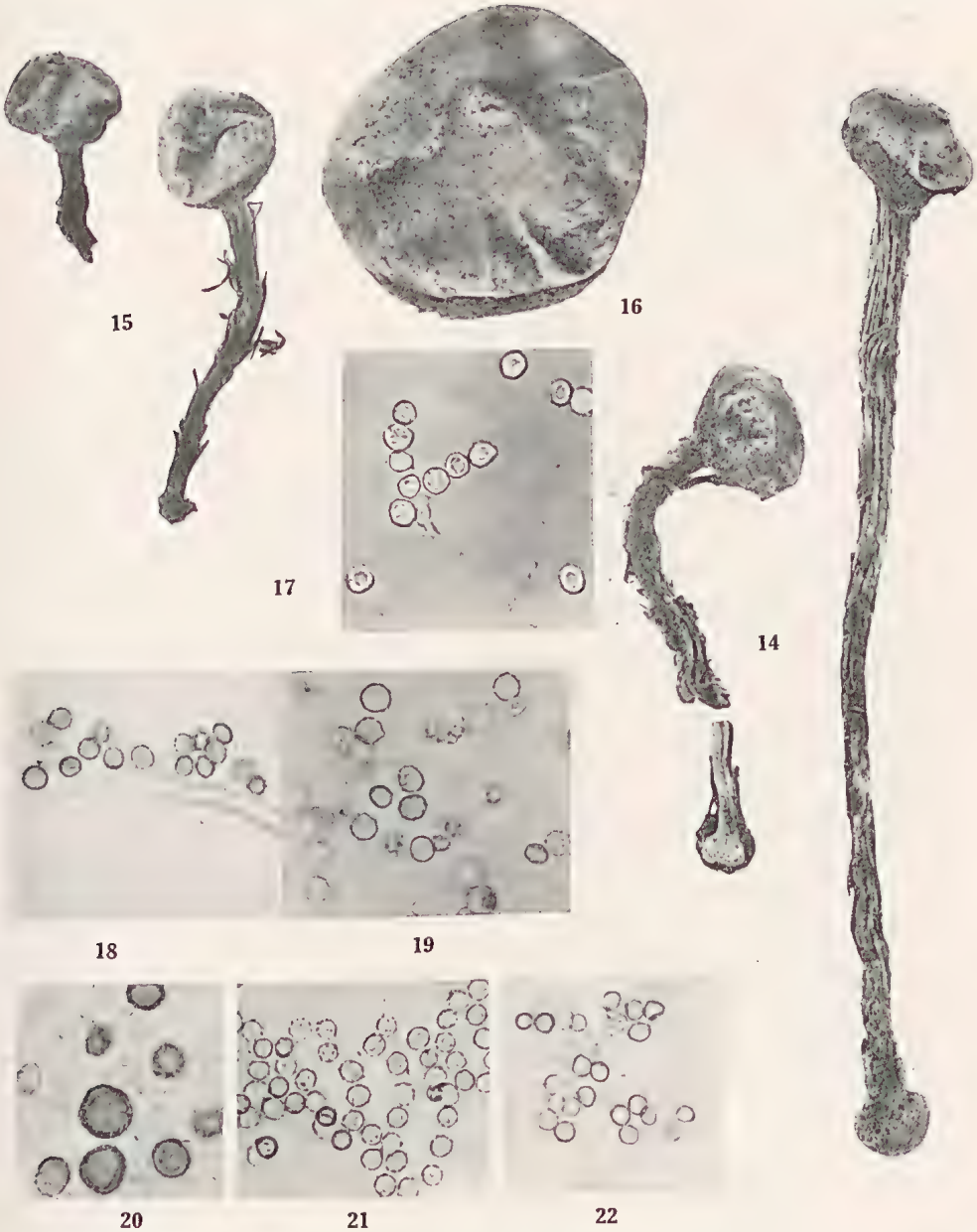
Species of *Tulostoma*.

1. *pubescens*. 2. *albicans*. 3, 4. *McAlpinianum*. 5. *macrosporum*. 6. *adhaerens*.

Species of *Tulostoma*.

7. *adhaerens*. 8. *brumale*. 9. *Purpusii*. 10, 11. *poculatum*. 12. *subfuscum*. 13. *striatum*.





Species of *Tulostoma*.

14-16. *australianum*. 17. *striatum*. 18. *subfuscum*. 19. *albicans*. 20. *macrosporum*. 21. *brumale*. 22. *poculatum*.

NATIONAL MUSEUM
VICTORIA

TWO NEW SPECIES OF *CALLISTEMON*, WITH NOTES ON CERTAIN OTHER SPECIES.

By Edwin Cheel,

Curator of the National Herbarium, Sydney.

[Read 29th July, 1925.]

Callistemon subulatus, n.sp.

Low-spreading shrub with numerous stems or branches arising from the base, which, when crowded together, form compact bushy shrubs more than 4 feet high, the individual stems more or less virgate or of whip-stick nature, rarely exceeding 2 to 3 cm. in thickness.

Leaves more or less subulate-awl-shaped, or occasionally semi-terete, sharp-pointed, with a somewhat obscure midvein slightly channelled on the underside, which is only visible under a lens; 3½ to 4 cm. long, usually 3 to 4 mm. broad and comparatively thick, so much so that the venation and oil-glands are invisible when held up to the light, but a few oil-glands may be seen on the upper and lower surfaces as minute raised dots in dried specimens; slightly hairy in the juvenile stage, but soon becoming glabrous with age or when properly matured.

Spike 5 to 8 cm. long, with a few scattered hairs along the rachis when young, but becoming glabrous when fully matured. Bracts from broadly-ovate to narrow-linear, more or less convolute striate, and covered with soft silky hairs, varying in length from 5 to 12 mm. Calyx-tube usually glabrous, or a few scattered hairs at the base, except in some specimens from Dorrigo and Gippsland which are rather more hairy than the type specimens, but otherwise the characters appear to be the same. Sepals ovate or semi-orbicular, somewhat brownish or slightly tinged with purple, rarely exceeding 2 mm. in diameter. Petals green, orbicular, 2 to 3 mm. diameter, glabrous or the margin very slightly ciliate. Stamens 1½ to 2 cm. long, the filaments as well as the anthers of a rich crimson colour. Style greenish, 2½ cm. long, with a comparatively conspicuous globose stigma. Fruits 3-celled, crowded together in the spike, the individuals truncate at the orifice, usually about 3 to 4 mm. diameter or rarely exceeding 5 mm.

I have chosen, for the type, specimens collected from plants growing along the bed of the Nattai River in October, 1912, which were exhibited at the October, 1915, meeting of this Society (vide These Proceedings, xl, 1915, 626). Several seedlings have been raised from the Nattai River plants and have been cultivated at Ashfield and at the Botanic Gardens, Sydney, as well as at Hill Top, at an elevation of 2,000 feet, and the offspring have flowered (during the past three years) and in no way differ from the parent plants. In comparing them with other known species, it is interesting to note that the foliage character and the habit of the plant is somewhat like *C. Sieberi*, but the filaments and anthers of the latter are creamy-white and much shorter than those of the new species, and the fruits are also different.

Its nearest affinity is with *C. lanceolatus*, but the smaller and differently shaped leaves, as well as the fruits, are quite distinct. In the National Herbarium, Sydney, there are specimens from the following localities:

New South Wales: Nattai River, via Hill Top (E. Cheel, January and October, 1912, and October, 1913); Conjola (W. Heron, January, 1900), determined by the late Mr. E. Betche as a "Narrow-leaved form of *C. lanceolatus* approaching *C. rigidus* and almost intermediate between the two. Fruiting specimens wanted." As mentioned above, it is quite distinct from *C. lanceolatus*, both as regards the habit of the plant, as well as the structural characters of the bracts and fruits. Mr. Betche afterwards altered his decision and erased the name *lanceolatus* and substituted *rigidus*, but it is more distinct from *C. rigidus* than *C. lanceolatus*; Nowra (J. L. Boorman, February, 1910); Moruya (J. L. Boorman, November, 1911); Dorrigo (W. Heron, November, 1912); Wyndham (J. L. Boorman, August, 1915); Cotter River (C. Weston, July, 1917); Heathcote (E. Cheel, in bed of the river).

Victoria: Near Cann River, Gippsland (H. B. Williamson, No. 1619, January, 1918).

Callistemon Chisholmi, n.sp.

Plants of a shrubby habit, or occasionally growing into small trees, the lower part of the trunk and branches with bark similar to that of the black tea-tree, which is of a fibrous nature, the upper branches and branchlets comparatively smooth.

Leaves 5 to 8.5 cm. long, 4 to 7 mm. broad, linear-lanceolate, acuminate coriaceous, the lateral veins rather oblique, just visible to the naked eye, intramarginal veins quite close to the margin of the leaf. Oil glands numerous, visible when held up to the light, raised into minute tubercles on both sides of the leaves when dried and examined with an ordinary lens.

Spike up to 8 cm. long, the rachis slightly woolly, bracts glabrous, faintly striate. Calyx-tube glabrous, lobes glabrous, greenish coloured with tinge of purple, petals greenish, tinged with red or purple, glabrous, or the margin minutely ciliate. Stamens about ¾ inch long, the filaments as well as the anthers, of a crimson or blood-red colour. Style slightly exceeding the stamens. Fruits sub-cylindrical, 4 mm. long, 3 mm. diameter, with a thin rim and truncate orifice, the valve rather deeply sunk.

The plant has some resemblance to *C. linearifolius* and *C. rigidus*, but is distinguished by the leaves being less prominently veined, and the paler filaments and differently shaped fruits. It is named in honour of Mr. J. R. Chisholm, who has interested himself in the flora of the remote parts of Northern Queensland.

Habitat.—Western watershed, Thompson River Fall, North Queensland (J. R. Chisholm, August, 1921).

Callistemon linearifolius DC.

Metrosideros linearifolia Link, *Enumer. Pl. Hort. Berol.* ii, 1822, 26.—*C. linearifolius* DC., *Prodromus*, iii, 1828, 223.

Bentham (1866) includes this under *C. rigidus* R.Br., as a synonym, but the specimens in the National Herbarium, Melbourne, labelled *C. linearifolium*, were collected in the neighbourhood of Parramatta by Woolls. Specimens collected by the writer quite close to Granville Station are almost identical with those collected by Woolls. Other localities are Clyde, Macquarie Fields, Cabramatta,

Hornsby, Lane Cove River, Cowan and Berowra. Plants cultivated at Ashfield, raised from seeds collected at Hornsby, flowered in October, 1921, and proved to be quite distinct from *C. acuminatus* Cheel (see THESE PROCEEDINGS, xl, 1915, 626), which it very closely resembles and for which it had been mistaken; it is also quite distinct from *C. rigidus* R. Br.

CALLISTEMON PACHYPHYLLUS Cheel.

The type specimens were collected at Bulahdelah and a description, together with an illustration, has been published (Cheel, 1911). Plants raised from seeds of the type have been cultivated in the Botanic Gardens and the colours matched that given as crimson-red (in bud) (see Dauth., *Repert. des Coul.*, 114, 2), tending to strawberry-red (Dauth., 110, 1) and finally dull-dark crimson (Dauth., 168, 3). Additional localities are Byron Bay and Wallis Island.

In addition to the normal form or species, some distinctive varieties have been collected which may be described as follows:

C. PACHYPHYLLUS var. ANGUSTIFOLIUS.

Flowers similar to the type, leaves smaller, narrow-linear, 3½ to 6 cm. long, 3 to 4 mm. broad.

Habitat.—Wardell (W. Bauerlen), Coff's Harbour (J. L. Boorman).

C. PACHYPHYLLUS var. VIRIDIS.

Leaves similar to var. *angustifolius*, but filaments yellowish-apple-green (Dauth., 266, 1 and 2).

Habitat.—New South Wales: Coff's Harbour (J. L. Boorman, June, 1911, and March, 1912; also A. Webber, June, 1920). *Queensland*: Caloundra (Miss E. Taylor, September, 1920—comm. by C. T. White, Government Botanist, Queensland, and marked C).

C. PACHYPHYLLUS var. RUBRO-LILACINUS.

Leaves and other characters similar to the type, but the filaments are of a reddish-lilac tint (Dauth., 179).

Habitat.—Caloundra (Miss E. Taylor, comm. by C. T. White).

CALLISTEMON RUGULOSUS DC.

Prodromus, iii, 1828, 223.

The description given by Decandolle is in latin and may be translated as follows: "Leaves linear-lanceolate, rigid, mucronate, plain, oil-glands raised on one surface and on the margins into minute tubercles, somewhat scabrous, 3-nerved, the lateral nerves parallel and close to the margin. Fruits glabrous." The following are given as synonyms: *Metrosideros rugulosus* Willd., *M. scabra* Coll., *M. glandulosa* Desf. and *M. macropunctata* Dum. Cours. It is also described by Link (1822) who quotes Willdenow's work, and from the brief latin description given, there can be no doubt it is the same species. Then we have Miquel (1856) who gives the habitat as "arid parts of New South Wales, together with Encounter Bay, Lake Alexandriae, Gawler Town, Lyndock Valley and Crystal Brook." Dr. Behr is given as the collector of specimens from the South Australian localities. Mueller (1858-59) seems to have been under the impression that Miquel's species was distinct from that of Decandolle and describes it under the name *C. coccineus*, giving as localities: St. Vincent's Gulf, Murray River, Spencer's Gulf, Flinders Range and Kangaroo Island. The latter are in the Melbourne Herbarium, and are in no way different from those which I have also

examined from Gawler Town and Lyndock, both of which localities are quoted by Mueller for his *C. coccineus*. Bentham (1866) evidently follows Mueller in regarding *C. coccineus* F. v. M. as distinct from *C. rugulosus* DC., and includes as synonyms: *Metrosideros rugulosa* Desf. together with *Callistemon scaber* Loddiges (*Bot. Cab.*, t. 1288). From a careful analysis of Decandolle's description and a close study of the figure of Loddiges, it seems clear to me that Miquel's and Mueller's species in no way differ from that of Decandolle. We may also include *C. coccineus* F. v. M. of Moore and Betche (1895), Bailey (1900) and J. E. Brown (1882). This species is frequently cultivated in gardens and there are several specimens from garden plants represented in the herbaria of Sydney and Melbourne. There are also specimens from Cygnet Bay, Wirraba Forest, Laura, Port Lincoln and Hog Bay. Victorian localities are as follows: Lake Albacatya, N.W.; Mount Arapilis; and without specific locality specimens collected by Hooker and Mueller labelled "*C. coccineus*, *C. rugulosus* Miq. vix DC."

Callistemon laevifolius.

C. rugulosum var. *laevifolia* F. v. M., in Miquel, *Ned. Kruidk. Arch.* iv, 1856, 141.—*C. coccineus* var. *lacvifolius* F. v. M., *Fragm. Phytog. Aust.* i, 1858-59, 13.

The original plants were collected in Port Lincoln by Wilhelmi in 1852. Miquel described it as a variety of *C. rugulosum* DC., and Mueller regarded it as a variety of *C. coccineus* F. v. M., but, although the filaments are similar in colour to those of *C. rugulosus*, the habit of plant and differences in foliage and other characters are so marked that it is proposed to raise it to specific rank.

Plants of a spreading shrubby habit. Leaves 1 to 1½ inches long, 3 to 5 lines broad, rather broadly-lanceolate, obtuse, but the mucro at the apex very prominent. Lateral veins obscure, but the central and marginal nerves much more prominent. Oil-glands entirely obscured owing to the thickness of the cuticle, quite smooth. Bracts, calyces, petals, filaments and fruits similar to those of *C. rugulosus*.

Distribution.—In addition to the Port Lincoln specimens, there are collections made at Coffins Bay (J. H. Maiden, January, 1907), Venus Bay (Major Warburton in 1859), and near Spencer's Gulf (without the collector or date being given). In the Melbourne Botanic Gardens there is a very fine plant cultivated by the late Mr. W. R. Guilfoyle labelled *C. coccineus* var. *splendens*.

Callistemon lilacinus.

Plants of this were raised from seeds originally obtained from the Botanic Gardens, Berlin, in 1913, labelled *C. lanceolatus* var. *lilacina*. The habit is quite distinct from *C. lanceolatus*, commonly found in the Port Jackson district, as will be seen from the following description: Filaments of a purplish-mauve-lilac colour (Dauth., Pl. 186). The leaves are similar to those of *C. rugulosus* in shape, but are much thinner in texture and the oil-glands are not raised on the surface.

Specimens identical with those raised from Berlin seeds sown under No. 856 on 29th May, 1913, have also been collected near Como by the late Mr. E. Betche in November, 1894, and recorded (These Proceedings, xxx, 1903, 884) under the name *C. coccineus* F. v. M., on account of the filaments and anthers being of the same colour. A closer study, however, of plants under cultivation in the Botanic Gardens, Sydney, and at Ashfield, has convinced me that they are quite distinct from both *C. rugulosus* and *C. lanceolatus* with which they have been previously confused. This view has also been confirmed, through the discovery of plants

growing wild at Gosford by Mr. T. Johnston in November, 1921. The late Mr. J. H. Camfield also collected specimens in the Port Jackson district without giving the specific locality in November, 1894. It is a most beautiful plant when in flower, some of the forms flowering nearly all the year round. Variants have also been produced from the typical *C. lilacina*, which suggest that its origin is probably as a result of hybridism. The variants may be described as follows:

C. LILACINA—CARMINA.

Similar in habit to the type, but the filaments are of a rich reddish-plum colour or deep carmine-violet (Dauth., Pl. 174, 4). Attention was drawn to this form by an exhibit of fresh flowering specimens at a meeting of this Society (THESE PROCEEDINGS, xlvii, 1922, xxviii).

C. LILACINA—ALBA.

Filaments creamy-white with very faint flush of rose.

It is interesting to note that two plants have been discovered in nature at Long Bay, by Mr. H. Burrell, of the true *C. lanceolata*, but with the filaments pure white. One of the latter is now cultivated in the Botanic Gardens, Sydney, and the other at Taronga Park. The habit of the plant and character of foliage of the latter form are quite distinct from the *lilacina* forms.

CALLISTEMON FLAVO-VIRENS.

C. rugulosus var. *flavo-virens* Cheel, in Maiden, *Illust. N.S. Wales Plants*, iii, 1911, p. iv.

Leaves 2½ to 4 inches long, 3 to 6 lines broad, linear-lanceolate, acute, somewhat attenuated at the base, and thickly studded on both sides with comparatively prominent raised oil-glands. Inflorescence and young shoots densely clothed with silky-pubescence. Flower-spikes 2 to 3½ inches long. Bracts very variable, 4 to 7 lines long, minutely pilose or even villous in some spikes. Calyx-tube villous, the lobes very short, rounded, deciduous. Petals rather larger than those of *C. rugulosus*, greenish, sprinkled with a few resinoid oil-glands. Filaments about 7 to 9 lines long, yellowish-green in colour, anthers yellow. Fruits somewhat more contracted at the orifice than those of *C. rugulosus* and more closely resembling those of *C. phoeniceus* from Western Australia.

In the National Herbarium, Sydney, there is a fine series of specimens collected by Mr. J. L. Boorman, who in his notes states "it is a yellow form of *C. lanceolatus*, 2 to 4 feet high, in the beds of creeks at Boonoo-Boonoo and Stanthorpe." Some fine seedling plants of this were raised from seeds collected at Stanthorpe and cultivated in the old native flower border in the Botanic Gardens, Sydney, and also in the Native Flora Plantation in the Centennial Park. The characters of the seedling plants were in no way different from those of the parent plants, and although included as a variety of *C. rugulosus* in the descriptive key drawn up by the writer (1911) I now find the characters sufficiently distinct from those of *C. rugulosus* in that the filaments are of a yellowish-green without any trace of rosy-pink, and the leaves are longer, thinner in texture, and the oil-glands are more numerous and, although distinctly raised as minute tubercles on both surfaces, the margins are not in-rolled nor scabrous as in *C. rugulosus*. It is therefore proposed to raise this to specific rank in view of seedlings breeding true. There are also specimens collected from a plant cultivated in the Domain Gardens, Christchurch, New Zealand, by the writer in March, 1909, which appear to belong to this species.

Callistemon pallidus DC.

The original description of Decandolle (1828) is in latin and may be freely translated as follows:

"Leaves glaucous oboval-oblong, mucronate, glabrous when fully matured, lateral nerves barely visible, calyx-tube glabrous."

Decandolle's description is evidently based on specimens collected in Tasmania during Baudin's Expedition and figured by Bonpland (1813) under the name *Metrosideros pallida.* Hooker (1860) included this species under *C. salignus* as a synonym and states that it is abundant on river banks in all parts of the colony. Hooker further states that at first sight this does not appear to differ much from *C. viridiflorum*, but it is quite a distinct species, having much longer and less rigid leaves, with shorter stamens, and that he can find no difference between them and *C. salignus* DC. as found in New South Wales, and the Tasmanian plant, except that the calyces of the former (*C. pallidus*) are sometimes, but not always, hairy and the leaves are hardly as long.

Hooker's latter remarks were in reply to Planchon, who, having examined Hooker's herbarium, had pointed out that the Tasmanian plants under the name *C. salignus* were distinct from the New South Wales plants under the same name (vide Hook., *Fl. Tasm.*, i, p. 131).

Bentham evidently recognized that the Tasmanian plants were distinct from the New South Wales plants and describes them as varieties under the names *C. salignus* var. *hebestachyus* and var. *viridiflorum.*

The following is Bentham's description of *C. salignus* var. *hebestachyus*:

"Leaves rather small. Calyx and rhachis pubescent or villous." The specimens examined by Bentham are in the National Herbarium, Melbourne, and as types we may take those from South Port and Mersey River, collected by C. Stuart in January, 1850, under No. 1637.

In the National Herbarium of Sydney there is also a fine series of specimens, identical with those examined by Bentham and which appear to me, to have scarcely any resemblance, except in the colour of the flowers, to the common coastal *C. salignus* DC. of New South Wales, and, besides, the oil-glands and venation afford sufficiently distinctive characters as shown in the key to the species (Cheel, 1911). In order to separate them, I propose to adopt Decandolle's name *C. pallidus* to include the larger broad-leaved form which is common in Tasmania and also the name *C. viridiflora* DC. for the smaller stiff-leaved, greenish flowering form.

The *C. lophanthum* Sweet (1827-28) quoted by Bentham as a synonym in connection with his *C. salignus* var. *hebestachyus* seems to be somewhat different from the Tasmanian plants, but may be only garden forms of the same species, as they are stated by Sweet to have been introduced into English gardens from France.

As there are no mature fruits figured in connection with either of the above-mentioned illustrations it is very difficult to judge as to whether they are seedlings from the New South Wales plants or from those of Tasmania.

It will be noticed from the figures that the lateral venation is not very prominent and as the lateral venation in all the New South Wales plants (of *C. salignus*) is very prominent, they can scarcely belong to this species and are best referred to *C. pallidus* DC. as synonyms for the present, especially seeing that several seedlings raised from seed of *C. salignus*, which are now under cultivation under varying conditions, all show the same characteristic features of the parent plants and have no resemblance to those from Tasmania.

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————, 1922.—PROC. LINN. SOC. N.S.W., xlvii, p. xxix.
COLLA, LUIGI.—*Hort. Ripul.*, p. 91 (quoted by Decandolle under *C. rugulosus*).
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DESFONTAINES, R. L.—*Cat. Pl. Hort.*
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A COMPARISON OF THE MALE GENITALIA OF THE PALAEOSETIDAE WITH THOSE OF OTHER LEPIDOPTERA HOMONEURA.

By John R. Eyer, Pennsylvania, U.S.A.
(*Communicated by A. J. Turner, M.D., F.E.S.*)

(Twelve Text-figures.)

[Read 26th August, 1925.]

The lepidopterous family Palaeosetidae was described by Turner (*Proc. Ent. Soc. Lond.*, 1921, 599). Based on a study of the type, *Palaeoses scholastica* Turn., the family was assigned a position in the Hepialoidea of the Lepidoptera Homoneura, differing from the families Hepialidae and Prototheoridae in certain structural details of the wing venation, mouth parts and tibial spurs. Through the courtesy of Dr. Turner, the author has been able to examine the male genitalia of this interesting family, and the following is a comparison of these structures with those of other Lepidoptera Homoneura. An attempt is also made to express the characters offered by these structures in a numerical manner, much as Tillyard (Proc. Linn. Soc. N.S.W. 1919, 275-328) has done with the wing venation, and thus calculate the percentage of archaic characters preserved in the genitalia of each family.

In comparison with the genitalia of other Lepidoptera Homoneura the genitalia of *Palaeoses* (Text-figure 11) exhibit the following distinctive features. The eighth sternite is normal in size and shape, neither heavily chitinized, as it is in the Hepialidae, nor rudimentary or absent, as in the Micropterygidae. The ninth sternite or vinculum is U-shaped and of moderate size, as in certain Hepialidae, e.g. *Hepialus lupulinus* L. (Text-figure 7). The tegumen, or fused ninth and tenth terga, is narrow, emarginate on the meson of the dorsal surface and bears two pairs of anal processes, one pair caudad of the anus and the other slightly laterad. These processes closely resemble similar ones in the Prototheoridae (Text-figures 9 and 12), but are longer and more attenuate. Similar processes also occur in certain Hepialidae (Text-figures 8 and 10), but usually in this family the lateral pair are fused with the aedeagus and become a part of the intromittent organ. The pleural region of the tegumen in *Palaeoses* is expanded on each side and forms a pair of lateral lobes similar to those in certain species of *Micropteryx* (Text-figure 6), but directed inward rather than caudad as in *Micropteryx*.

The juxta consists of a quadrate chitinized plate situated on the meson directly caudad of the vinculum. It is similar to the same structure in the Hepialidae and Prototheoridae. The aedeagus, a recurved chitinized process, is articulated to the caudal margin of the juxta and forms the ventral support for the membranous penis. A similar type of aedeagus is present in many Hepialidae, *H. lupulinus* (Text-figure 7) *et al.* As will be seen in Text-figure 9, the aedeagus of the Prototheoridae is more complicated, having a large semi-membranous terminal portion armed with a pair of recurved processes and lateral lobes. The harpes or valves of *Palaeoses* are articulated to the lateral margins of

Description.—Usually upright bushy shrubs which often develop into a small tree somewhat resembling *C. salignus* DC. in general appearance, but may be distinguished by the less flexile and less drooping branches so characteristic of the latter species. Leaves clothed with appressed silky silvery-coloured hairs when young, not rufous as in *C. salignus*, which drop off with age; the leaves then are of a pallid-green or somewhat glaucous colour. Oblong or oboval in general outline, slightly tapering at the base and terminating at the apex with a sharp mucro, thicker in texture than those of *C. salignus* and as a consequence the venation is not so prominent, varying in size from about 1 to rarely more than 2¼ inches long and 3 to 6 inches broad.

Oil-glands appearing on both sides of the leaves as minute tubercles quite visible to the naked eye. Flower-spikes from 2 to 3½ inches long, the rachis pubescent or villous or rarely almost glabrous. Bracts not seen, apparently very deciduous. Calyx-tube cylindrical or campanulate, the lobes very small and generally villous. Petals greenish, slightly pubescent, the margins sometimes fringed with soft hairs, and the underside usually dotted with resinoid oil-glands. Stamens creamy-coloured or yellowish, tinged with a greenish-tint, ½ to ¾ inch long, anthers slightly darker in colour than the filaments. Fruits ovate or semi-ovate, with a truncate orifice and thick rims, the valves nearly level with the rim.

Synonyms.—*Metrosideros pallida* Bonpland (1813); *Callistemon salignus* Hook. (1860) (not DC.); *C. salignus* var. *hebestachyus* Benth. (1866); *C. lanceolatus* Ewart (1909) (not DC.).

What appear to be only forms of the same species are also found on mountain peaks in this State (New South Wales) and Victoria at altitudes above 2,000 feet. The localities are as follows:

Victoria: Buffalo Range (F. v. Mueller, 1856); Granite Hill, Wilson's Promontory (J. W. Audas, November, 1908).

New South Wales: Mount Warning (W. Forsyth, November, 1898, and R. H. Cambage, January, 1913), Jenolan Caves (W. F. Blakely, July, 1899), Clyde Mountains, near Nelligen (J. L. Boorman, March, 1909), Top of Tidbinbilla (5,000 feet western side, R. H. Cambage, No. 3052, Nov., 1911), Yerranderie (R. H. Cambage, October, 1909), Barren Mountain, near Meldrum (J. L. Boorman, December, 1915), Mount Jellore (2,000 feet, E. Cheel, May, 1916), Barrington Tops (J. L. Boorman, December, 1915, L. Harrison, January, 1925).

There are also specimens in the National Herbarium, Sydney, collected at Yarrowitch near Walcha by J. H. Maiden in November, 1897, and at Stanthorpe, Queensland, by J. L. Boorman in July, 1904, which vary slightly from the Tasmanian forms, but may be safely included under this species. Some Stanthorpe specimens with coriaceous leaves referred to by Bailey (1900) seem to belong to this species, rather than to *C. lanceolatus*.

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the juxta and each is divided into two areas, a narrow finger-like sacculus and a broad spoon-shaped cucullus. The harpes of the Prototheoridae and most Hepialidae are undivided, but a type somewhat similar to that of *Palaeoses* is to be found in *H. hectoides* Boisd. (Text-figure 8).

The male genitalia of *Palaeoses* have little in common with those of the Micropterygoidea which depart quite markedly from those of the Hepialoidea and approach the type of genitalia found in the primitive Tineoidea. Only in the Mnesarchaeidae (Text-figures 1, 4, and 5), are any distinct Hepialoid tendencies preserved. A U-shaped vinculum, similar to that of *Palaeoses* and many Hepialidae, occurs in this family, and *Mnesarchaea fusca* Philp. (Text-figure 5) possesses a pair of anal processes probably homologous with the more caudal pair of *Palaeoses* and *Prototheora*. The penis is membranous in the Mnesarchaeidae and is occasionally supported on the ventral side by chitinized spines, possibly the vestige of the aedeagus. In the Micropterygidae (Text-figures 3 and 6) and the Eriocraniidae (Text-figure 2) the aedeagus forms a tubular chitinized sheath for the penis, the juxta is greatly reduced in size and the harpes are often partially articulated to the vinculum.

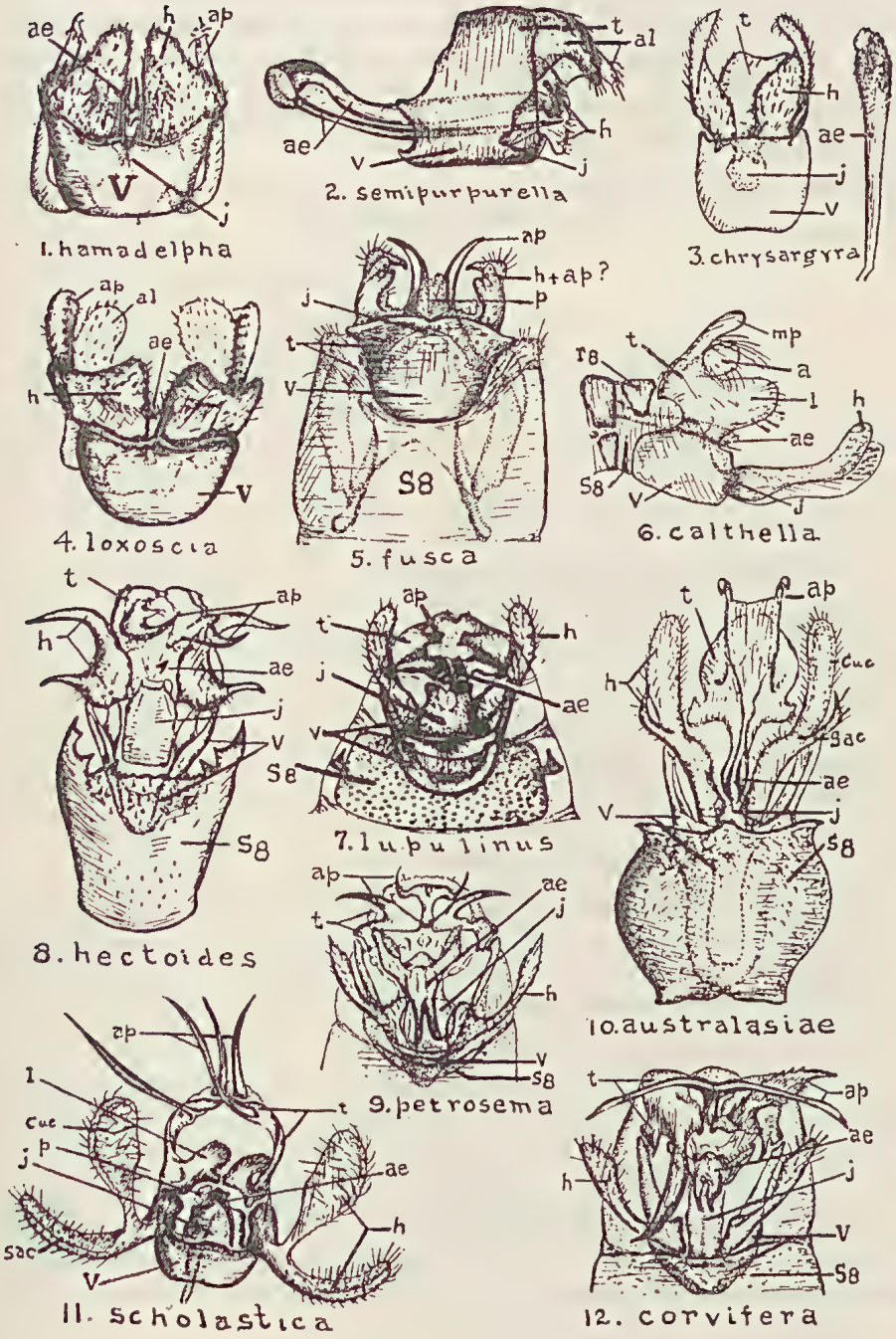
As previously mentioned a comparison of the archaic characters retained in the wings of the Lepidoptera Homoneura has been made by Tillyard. He used as the basis for this comparison the wing of *Belmontia*, the fossil ancestor of the Lepidoptera and Trichoptera, in which the maximum number of archaic characters were preserved. Unfortunately no such ancestral type of genitalia is at present known. From a study of the types of genitalia in the Lepidoptera and those insect orders closely related to the Lepidoptera, i.e. Neuroptera, Mecoptera and Trichoptera, some idea is obtained of the relative value of each structure comprising the genitalia complex and a hypothetical ancestral type may be postulated. The characters of such a type, as explained by the author in a previous publication (*Ann. Ent. Soc. Amer.*, 1924, 275-343), are as follows: Tegumen hood-like, composed of the fused ninth and tenth terga, often armed with one or more anal processes which seldom become definite enough in shape and position to be homologized with the uncus and gnathos of the Lepidoptera Heteroneura; vinculum composed of the ninth sternite which retains its normal shape and size; eighth sternite unmodified; harpes or valves undivided, at least in part articulated to a membranous or lightly chitinized basal plate or juxta; penis membranous and encased in a tubular, lightly chitinized aedeagus.

Text-figs. 1-12.

1. *Mnesarchaea hamadelpha* Meyr. Ventral aspect
2. *Eriocrania semipurpurella* Stph. Lateral aspect.
3. *Sabatinca chrysargyra* Meyr. Ventral aspect.
4. *Mnesarchaea loxoscia* Meyr. Ventral aspect.
5. *Mnesarchaea fusca* Philp. Ventral aspect.
6. *Micropteryx calthella* L. Lateral aspect.
7. *Hepialus lupulinus* L. Ventral aspect.
8. *Hepialus hectoides* Boisd. Ventral aspect.
9. *Prototheora petrosema* Meyr. Ventral aspect.
10. *Perrissectis australasiae* Don. Ventral aspect.
11. *Palaeoses scholastica* Turn. Ventral aspect.
12. *Metatheora corvifera* Meyr. Ventral aspect.

Abbreviations.

a—anus, *ae*—aedeagus, *al*—anal lobe, *ap*—anal process, *cuc*—cucullus, *h*—harpe or valve, *j*—juxta, *l*—lateral lobe of tegumen, *mp*—median process of tegumen (possibly the homologue of the uncus), *p*—penis, *sac*—sacculus, S_8—eighth sternite, T_8—eighth tergite, *t*—tegumen or fused ninth and tenth terga, *v*—vinculum or ninth sternite.


ae
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1. hamadelpha
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2. semipurpurella
t
h
ae
j
V
3. chrysargyra
ap
al
ae
h
V
4. loxoscia
ap
h+ap?
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S8
5. fusca
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mp
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S8
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6. calthella
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S8
8. hectoides
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7. lupulinus
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S8
12. corvifera

In the following table the characters of the male genitalia for the families of the Lepidoptera Homoneura, with the exception of the Anomosetidae, are summarized, together with calculations of the percentage of archaic characters retained by each. The hypothetical archaic type just described is regarded as possessing 100% archaic characters. Six characters are tabulated, each of which is regarded as a separate unit, and the extent to which each is retained in its primitive state in the different families is expressed in fractions of 100.

TABLE OF ARCHAIC GENITALIA CHARACTERS RETAINED IN FAMILIES OF LEPIDOPTERA HOMONEURA.

Character.	Micropterygidae.	Palaeosetidae.	Prototheoridae.	Hepialidae.	Mnesarchaeidae.	Eriocraniidae.
Eighth Sternite: 1. Normal, same shape and degree of chitinization as other abdominal sterna—100 2. Hind margin heavily chitinized—66⅔ 3. Entirely chitinized, plate-like—33⅓ 4. Dechitinized, vestigial or wanting—0	0	100	66⅔	33⅓	100	100
Ninth Sternite: (Vinculum) Shape: 1. U-shaped or quadrate, same size as other sterna—100 2. U-shaped or quadrate, somewhat elongated—75 3. Irregularly U- or V-shaped, elongated—50 4. Emarginate, outer angles of front margin produced—25 5. Narrowly transverse, often with saccus—0* Position: 1. Normal—100 2. Front margin retracted beneath 8th sternite—50 3. Entire sternum retracted beneath 8th sternite—0	87.5	100	75	25	100	37.5
Tegumen: (Ninth and tenth terga) 1. Hood-like—100 2. Transverse with at least one pair of anal lobes—50 3. Emarginate or completely divided, with one or two pairs of anal processes—0	100	0	0	0	50	50
Valves or Harpes: (Size and complexity) 1. Large and simple—100 2. Medium size, occasionally divided—75 3. Medium size, invariably divided—50 4. Usually small—25 5. Vestigial or absent—0	100	50	75	75	25	0

TABLE OF ARCHAIC GENITALIA CHARACTERS RETAINED IN FAMILIES OF LEPIDOPTERA HOMONEURA.—(*Continued.*)

Character.	Micropterygidae.	Palaeosetidae.	Prototheoridae.	Hepialidae.	Mnesarchaeidae.	Eriocraniidae.
Juxta and Basal Attachment of Valves: 1. Valves entirely attached to juxta, juxta large—100 2. Valves one-half attached to juxta, juxta medium—66⅔ 3. Valves one-third attached to juxta, juxta small—33⅓ 4. Valves entirely attached to vinculum, juxta absent—0*	66⅔	100	100	100	33⅓	33⅓
Aedeagus: 1. Tubular, basal portion at least chitinized—100 2. Semi-tubular, dorsal and ventral surfaces chitinized—75 3. Plate or spine like—50 4. Plate like with elaborate terminal armature—25 5. Vestigial or absent—0	100	50	25	50	0	75
Average percentage preserved archaic characters	76	67	57	47	52	45

* Rarely found in Lepidoptera Homoneura but characteristic of certain Tineoidea and Macrolepidoptera.

Conclusions.

From the foregoing comparison it was seen that the male genitalia of *Palaeoses* possessed certain structures quite similar to or identical with those in the Prototheoridae and Hepialidae, i.e. the emarginate tegumen with two pairs of anal processes, the large juxta to which the harpes are entirely attached, and a non-tubular type of aedeagus. The vinculum, although shaped much like that of the Prototheoridae and certain Hepialidae is not retracted beneath the eighth sternite.

In the retaining of archaic characters, however, the genitalia surpass those of the Hepialidae and Prototheoridae and stand intermediate between the latter family and the Micropterygidae. As would be expected from the evidence offered by other structures, the Micropterygidae retain the greatest number of archaic genitalia characters in the families of the Lepidoptera Homoneura. In this respect the Eriocraniidae are the most specialized and the Mnesarchaeidae, which are less generalized than the Eriocraniidae in the matter of wing venation and mouth parts, retain more archaic characters than either the Eriocraniidae or the Hepialidae.

THE AUSTRALIAN SPECIES OF *ONCOPERA* (HEPIALIDAE, LEPIDOPTERA).

By JOHN R. EYER, Pennsylvania, and A. J. TURNER, Brisbane.

(Plate xxxii.)

[Read 24th June, 1925.]

Introduction (by A. J. Turner).

Some two years ago, in response to a request from Mr. Eyer for specimens of Hepialidae for the examination of their genitalia, I sent him examples of *Oncopera mitocera* Turn. taken in the National Park, Macpherson Range, Queensland. I was surprised to hear that I had, in his opinion, included another species, and it was only after a considerable time that I recognized that I had a second example of this previously unrecognized species, to which I have given the name *epargyra*. Meanwhile Mr. Eyer returned my first specimen with a microscope slide of the genitalia. These circumstances led me to make a critical examination of all my material, and I came to the conclusion that I had probably a third closely allied species from Herberton, for which I proposed the name *brachyphylla*. Mr. Eyer confirmed this from an examination of the genitalia, and sent me a slide of these, together with microphotographs of the genitalia of *mitocera* and *brachyphylla*, and a drawing of those of *intricata*. He also sent a key to the four species with the exception of *epargyra*, of which he had previously returned the only preparation he had made. Mr. A. Philpott, of the Cawthron Institute, Nelson, New Zealand, has very kindly completed the key, and Mr. W. C. Davies of the same Institute has sent me an excellent photograph of the genitalia of *epargyra*.

Key to the species of Oncopera *based on the characters of the male genitalia* (by John R. Eyer; *epargyra* by A. Philpott).

Group I. Sacculus absent.

Valves without sacculus, cucullus expanded and spoon-like; vinculum wide-margined and possessing a prominent median process to which the posterior margin of the eighth sternite is attached; eighth sternite triangular, longer than wide, and with the anterior margin emarginate; tegumen without anal spines; scale sacks on conjunctiva between eighth tergite and tegumen present; aedeagus a small transverse plate; opening of penis bounded laterally by two heavy processes from the meson of the tegumen ..... *mitocera* Turn.

Valves without sacculus, cucullus not expanded distally; vinculum narrow-margined and with the median process only slightly developed; eighth sternite rectangular, almost as broad as long; tegumen with a pair of short sharp anal spines; scale sacks absent; other characters as in *O. mitocera* ..... *intricata* Walk.

Group II. Sacculus present.

Valves with short sacculus, cucullus long and finger-like; vinculum narrow-margined and without median process; eighth sternite keystone-shaped; tegumen with two anal spines which are continuous with two long inner processes which cover the opening of the penis; scale sacks present; aedeagus a rectangular plate much longer than wide ..... *brachyphylla* Turn.

Valves with sacculus narrow and acutely pointed, almost as long as cucullus, cucullus less broad than in *brachyphylla*, not dilated apically; eighth sternite shuttlecock-shaped, upper angles projecting; vinculum broad, not emarginate, without median process; aedeagus a somewhat ovate plate ..... *epargyra* Turn.

Key to superficial characters and descriptions of new species (by A. J. Turner).

1. Antennae slightly clubbed towards apex. Femoral hair-tufts of ♂ very large and reaching beyond tarsi ..... *intricata*
   Antennae short, thread-like. Femoral hair-tufts of ♂ moderate and not reaching beyond tarsi 2
2. Expanse, ♂ 42-46 mm. Forewings elongate and rather narrow, without silvery-white markings or with dots only ..... *mitocera*
   Expanse, ♂ 35-40 mm. Forewings shorter and proportionately broader, frequently with oblique or longitudinal silvery-white streak 3
3. Forewings rather sharply pointed, with much fuscous suffusion. Hindwings with apices grey ..... *epargyra*
   Forewings with apex more bluntly rounded, little or no fuscous suffusion. Hindwings with apices not grey ..... *brachyphylla*

ONCOPERA INTRICATA Wlk. Plate xxxii, fig. 1.

New South Wales: Mt. Kosciusko. Victoria: Melbourne, Warragul, Gisborne. Tasmania: Hobart, Maria Island, Swansea, Bothwell, Launceston, Deloraine, Moina (2,000 ft.).

ONCOPERA MITOCERA Turner. Plate xxxii, fig. 2.

Annals Queensland Museum, x, 1911, p. 132.

North Queensland: Cairns, Atherton, Herberton. Queensland: National Park (3,000 ft.).

ONCOPERA EPARGYRA, n. sp. Plate xxxii, fig. 4.

ἐπάργῦρος, overlaid with silver.

♂. 36-41 mm. Head and thorax fuscous-brown. Antennae fuscous. Abdomen fuscous, becoming whitish-grey towards apex. Legs fuscous; posterior pair and tuft pale-ochreous. Forewings elongate-triangular, costa straight, slightly arched near base and apex, apex sharp-pointed, termen nearly straight, strongly oblique; dark-fuscous mixed with brown, paler towards base and costa; four or five fuscous spots on terminal half of costa; a variable, silvery-white, discal spot at two-thirds connected by a silvery-white oblique streak to dorsum before tornus, but this is not always present; cilia brownish barred with fuscous. Hindwings with apex round-pointed, termen slightly rounded; dark-fuscous; a suffused whitish-grey apical blotch, containing four costal fuscous dots; cilia as forewings.

Queensland: National Park (3,000 ft.) in December, two specimens.

ONCOPERA BRACHYPHYLLA, n. sp. Plate xxxii, fig. 3.

βραχύφυλλος, short-winged.

♂. 35-40 mm. Head and thorax brown. Antennae fuscous. Abdomen fuscous-brown. Legs brown. Forewings triangular, costa straight, arched towards apex, apex round-pointed, termen bowed, oblique; brown with little or no fuscous suffusion; costal area paler with some darker strigulae; a variable white discal mark at three-fourths, sometimes connected by an oblique white streak with dorsum before tornus; sometimes a short, broadly-suffused, white streak from base below middle; cilia brown. Hindwings with apex rounded, termen slightly rounded; fuscous-brown, cilia fuscous-brown.

North Queensland: Evelyn Scrub near Herberton, in January and February; four specimens received from Mr. F. P. Dodd.

Explanation of Plate xxxii (by John R. Eyer).

1. *Oncopera intricata* Wlk.
2. *Oncopera mitocera* Turn.
3. *Oncopera brachyphylla*, n. sp.
4. *Oncopera epargyra*, n. sp.

a—anus. A membraneous tube at the very caudal end of the genitalia usually opening just behind and on the meson of the tegumen.

ap—anal process. A pair of processes from the caudal margin of the tegumen which in the Hepialidae often surround the anus.

ss—scale sacks. A pair of eversible sacks covered with scales which occur on the conjunctiva between the 8th tergite and the tegumen. The Hepialidae is the only family in which I have found them to occur in this position. They are usually ventral and between the sternites.

t—tegumen. The ninth tergite which is highly modified to form the dorsal hood of the genitalia and surround the anus.

p—penis. A membraneous tube usually opening near the centre of the genitalia and in the Hepialidae often supported by a pair of processes from the meson of the tegumen.

pr—mesal processes of the tegumen just referred to.

ae—the aedeagus, i.e., the chitinized armature supporting the penis. In the Hepialidae it consists of a plate on the ventral wall of the penis; in the higher Lepidoptera it is usually a chitinized tube which completely surrounds the penis.

v—valve. A pair of finger-like claspers articulated to a median plate, the "juxta", and serving as claspers to hold the female during copulation. In species such as *brachphylla* the valves are divided into a posterior finger-like lobe, "cucullus", and an anterior acutely pointed lobe, the "sacculus". These lobes take many forms in various species of Lepidoptera but the sacculus is usually the more heavily chitinized and the cucullus the more hairy of the two.

j—juxta, just described above.

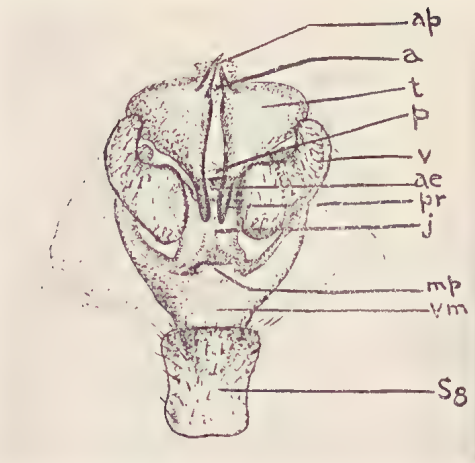
cc—cucullus, just described above.

sc—sacculus, just described above.

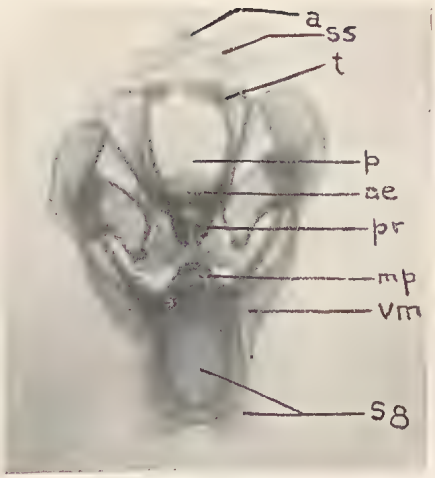
vm—vinculum. The ninth sternite usually modified to form a v- or u-shaped structure with a pair of lateral arms which extend dorsad to meet the tegumen.

mp—median process of the vinculum.

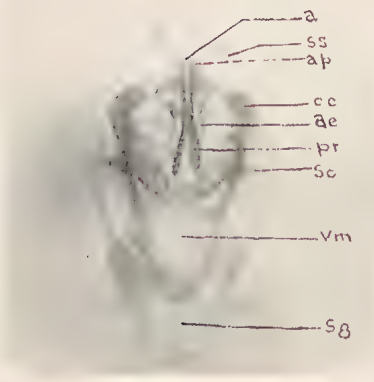
s8—eighth sternite. In the Hepialidae this forms a chitinized plate underlying the vinculum. Its shape varies in different species.



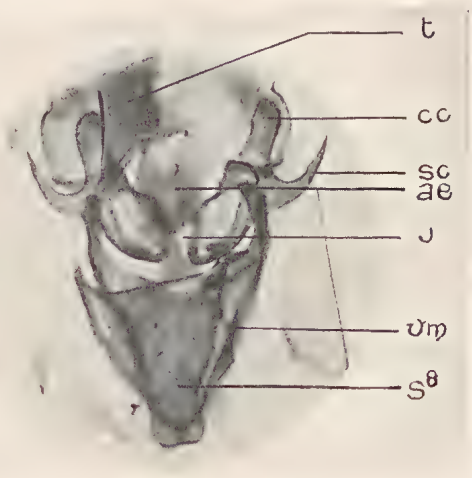
1. *Oncopera intricata.*



2. *Oncopera mitocera.*



3. *Oncopera brachyphylla.*



4. *Oncopera epargyra.*

NAL MUSEUM
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ON THE TACHINID GENUS *EUTHERA* (DIPTERA), WITH DESCRIPTION OF NEW SPECIES FROM AUSTRALIA, AFRICA AND SOUTH AMERICA.

By Prof. Mario Bezzi, Turin, Italy.

(Communicated by Dr. E. W. Ferguson.)

(Three Text-figures.)

[Read 26th August, 1925.]

To the Dipterous genus *Euthera* belong the most striking and beautiful forms of the family Tachinidae, and, as is the case with many other genera of this interesting family, the species seem to be very rare, only isolated specimens being found; perhaps the flies are met with only occasionally because the bionomics are quite unknown. The genus has a wide distribution, being recorded from North America and from the Mediterranean subregion. I know it, however, from the whole Ethiopian region, as well as from Australia and from South America. It is therefore of world-wide distribution, ranging from about latitude 45° North to 36° South.

The genus *Euthera* was founded by Loew (1866, pp. 46-47) with the single species *tentatrix*, based on a solitary specimen collected at New York by Baron Osten-Sacken. It is one of the eleven species of Tachinidae selected by Loew for description from one thousand species of North American Diptera; they are all striking forms (Loew, 1872, p. 122), but *Euthera* and *Himantostoma* (now *Imitomyia*) are the most striking of all. Osten-Sacken (1876, p. 154) has the genus *Euthera* near *Scopolia*, quoting the species from New York and Texas.

The next record of the genus *Euthera* is to be found in an important paper by Prof. Mik (1889, pp. 129-134), in which the author has presented notes on the characters, as well as on the systematic position, together with the description of the new species, *E. mannii* from Lesina, Dalmatia (one male, collected by Novak) and from Brussa, Asia Minor (one couple, collected by Mann). The paper is illustrated with two figures drawn by Prof. Brauer, and contains the information that the specimens from Brussa were already recognized by Osten-Sacken as belonging to *Euthera*. Prof. Mik is of the opinion that the genus belongs to the Phasiinae, *sensu* Rondani.

Brauer and Bergenstamm (1889, p. 140) have the genus in the group Schineriidae, between Ocypteridae and Gymnosomatidae, with a figure (Plate x, fig. 278) of the head of the female *mannii*; subsequently (1891, p. 411 and p. 433; 1893, p. 110 and p. 152) they have repeated the characters, assuming them always from the species *mannii*, the true genotype *tentatrix* being quite unknown to them.

Tyler Townsend (1892, p. 141 and p. 144) has placed *Euthera* with the Tachinidae, having excluded it from the preceding paper of 1891, dealing with Phasiidae, Ocypteridae, etc.

Prof. Brauer (1893, p. 474 and p. 493) again has the genus near *Schineria*, giving *mannii* as type.

Coquillett (1897, p. 37 and p. 120) has placed the genus near *Demoticus*, recording the species from Pennsylvania and Georgia. Williston (1896, p. 148) records only the name of the genus.

Prof. Strobl in his works on the Diptera from Bosnia and Dalmatia (1898, p. 443 and 1900, p. 597) quotes the species *mannii* from Island Lesina, but without having seen it.

Coquillett (1902, p. 114) described a second North American species, *Euthera bicolor*, from Texas, only from the female. Aldrich (1905, p. 469) records the genus near *Tachina*, with the two North American species, without adding new localities.

I myself (1907, p. 566) have the genus near *Selimeria*, with the species *mannii* and the usual citations.

Prof. Williston (1908, p. 374) has the genus near *Acemyia*, giving (p. 368, fig. 80 and 81) figures of head and of wing of *tentatrix*. Coquillett (1910, p. 543) gives *tentatrix* as genotype of *Euthera*, and Johnson (1910, p. 781) records the species *tentatrix* from New Jersey.

Tyler Townsend (1912, p. 49) places the genus *Imitomyia* in the subfamily *Phasiidae*, tribe *Eutherini*. Villeneuve (1913, p. 43) has recorded *E. mannii* from Nyasaland, but this record probably refers to one of the Ethiopian species described below. Tyler Townsend (1916, p. 178) erected the new genus *Eutheropsis* for *mannii*, defining it (1916*a*, p. 322) and locating it in the fam. *Rhadogynidae*.

Dr. Villeneuve (1924, p. 32) has considered the genus *Euthera* as forming a special tribe in the *Phasiinae*, with the genera *Hermyia*, *Clara*, *Baraclara*, etc.; while in the same year Prof. Stein (1924, p. 178) has the genus in the group *Trixa*, near *Redtenbacheria*.

Finally Johnson (1925, p. 204) has the genus in the Tachininae, near *Acemyia*, recording the species *tentatrix* from various localities.

From the above quoted works is to be seen how different are the opinions of authors about the systematic position of *Euthera*. In my collection I have placed it with *Schineria* near the Phaniinae, but Dr. Villeneuve (1924, p. 33) has placed the latter genus near *Echinomyia*, excluding it from the Phaniinae.

The seven known species, five of which are before me, can be distinguished as follows:—

1 (12) The small apical scutellar bristles diverging; female with orbital bristles, frontal bristles curved inwardly and all decussate; three pairs of dorsocentral and two pairs of acrostichal bristles before the suture; female with the frontal stripe considerably narrower than one of the parafrontalia, these latter very broad, shining black, not or slightly dusted; submarginal cell with hyaline spot.

2 (7) New World species; head entirely red, with quite bare parafacialia, with prominent mouth border and with rounded, swollen facial keel; front tarsi of female quite simple, coxae and femora reddish, second abdominal segment without strong macrochaetae in middle of hind border; wing-base and costal cells of a bright yellowish colour; calypters likewise yellowish and opaque (*Euthera, s. str.*).

3 (6) All the coxae reddish, tibiae and tarsi entirely black; terminal half of second costal cell and stigma blackish; third posterior cell quite hyaline; alula broadly yellowish at base; scutellum with two pairs of lateral bristles.

4 (5) Abdomen entirely shining black; the dark middle band of wings interrupted by broad hyaline streaks into the submarginal and the discoidal cell ..... *tentatrix* Loew.

5 (4) Abdomen reddish-yellow with brownish dorsal spots; dark middle band of wings much broader and not interrupted by hyaline streaks .... *bicolor* Coquill.

6 (3) Coxae in greatest part black, tibiae and tarsi reddish; second costal cell and stigma entirely yellowish; third posterior cell blackened; alula entirely black; no hyaline streaks into the middle band of wings; scutellum with three pairs of lateral bristles, the middle one smaller ..... *barbiellinii*, n. sp.

7 (2) Old World species; head in greatest part black; female with front tarsi flattened; coxae always black, second abdominal segment with strong macrochaetae; wing base whitish hyaline and costal cells blackish, third posterior cell partly infuscated; alula entirely black, calypters whitish hyaline (*Eutheropsis* T. T.).

8 (9) Mouth border prominent; facial keel swollen and rounded in profile, parafacialia distinctly pilose in their whole length; frontal stripe dark reddish .. *mannii* Mik.

9 (8) Mouth border not at all prominent; facial keel sharp, straight in profile, low; frontal stripe deep black.

10 (11) Palpi red; coxae and femora black; parafacialia thinly pilose in the middle; scutellum with a pair of diverging apical bristles and with a pair of discal ones; bend of fourth vein angular, the apical crossvein straight and less oblique ..... *tuckeri*, n. sp.

11 (10) Palpi black; coxae and femora red; parafacialia quite bare in middle, with only a few hairs above; scutellum with only the two pairs of lateral bristles, without apical and discal ones; bend of fourth vein more rounded, the apical crossvein more oblique ..... *péringueyi*, n. sp.

12 (1) Small apical bristles of scutellum decussate; female without orbital bristles; frontal bristles erected, not decussate; five presutural dorsocentral and three presutural acrostichal bristles, mouth border prominent, frontal stripe red, in the female much broader than one of the parafrontalia, these latter very narrow and densely dusted, not shining; face yellow in the middle, palpi red, wing base whitish hyaline, costal cells blackish; submarginal cell without hyaline spot; calypters white (*Macreuthera*, n. subgen) ..... *skusei*, n. sp.

Genus Euthera Loew.

For generic characters, sexual differences, etc., see Mik, Brauer and Coquillett. It may be added: facial ridges with 3-4 thin, bristly hairs just above the vibrissae, hind coxae destitute of bristles, all the wing-veins bare, even at common stem of radius and at base of third vein.

Subgenus Euthera, s. str.

The species of this subgenus are well characterized by the rich wing-pattern, having yellow base of wings and yellow calypters; they are exclusively American.

1. Euthera tentatrix Loew. Text-fig. 1, A.

This is the genotype known only from the United States (Massachussets, Pennsylvania, New Jersey, New York, Georgia and Texas). I have in my collection one female from Tifton, Ga., October, 1896, and another female from Great Notch, N.Y., 30th October, 1906. Seems to be an aestivo-autumnal species, being not found before August.

The male of the present species is not yet described; the possibility is not excluded that it may have an infuscate third posterior cell, as in *barbiellinii*.

2. Euthera bicolor Coquillett.

Described from Texas, without precise locality, and not found subsequently. The wing pattern seems to be like that of the following new species in the shape of the middle dark band, but the third posterior cell is quite hyaline.

3. Euthera barbiellinii, n. sp. Text-fig. 1, B.

Closely allied with the two preceding species, but distinct by the richer wing-pattern.

Type ♂, a single, badly preserved specimen in the writer's collection, caught near Sao Paulo, Brazil, by the Count A. A. Barbiellini, in whose honour this fine insect is named.

♂. Length of body 6 mm.; of wing 5 mm. Head entirely reddish, blackened only towards the middle of the occiput. Frons narrowed towards the vertex and there only one-half as broad as at antennae; parafrontalia black, densely dusted with grey; middle stripe red, at vertex as broad as one of the parafrontalia, but at antennae twice as broad; frontal bristles black, rather numerous, but not long, never strong, directed inward and decussate, extending below to the end of first antennal joint. Face entirely shining, yellowish with a narrow transverse black stripe in the middle; parafacialia as broad as the third antennal joint and rather opaque, being clothed with whitish dust, peristomialia shining, unspotted, twice as broad as the parafacialia, with whitish hairs behind. Antennae linear, elongate, longer than the face, with the two basal joints reddish and the third black; second joint three times as long as the first, with black setulae, third joint one and a half times as long as the second, attenuated at end; arista basal, entirely reddish, only a little longer than the third antennal joint, considerably thickened at base. Proboscis short and thick, dirty yellowish, palpi club-shaped,

Text-fig. 1. Wings of *Euthera*, enlarged.
A. *tentatrix* Loew; B. *barbiellinii*, n. sp.

reddish. Thorax and scutellum entirely black, but too badly preserved for description; scutellum with three pairs of lateral bristles, the apical ones small and diverging, no discal. Calypters greatly developed, bare above, entirely of a bright yellowish colour. Halteres with yellowish stalk and blackish knob. Abdomen entirely shining black with black setulae and black bristles, these latter rather thin and short, present only at hind border of the segments, on the first and second segment only at sides; venter with all the sternites concealed; genitalia rounded, black, of middle size, well visible but not prominent. Coxae and trochanters black, only those of the front pair in part reddish, femora, tibiae and basal joints of the tarsi reddish, claws and pulvilli short, but distinctly, even if little, more developed than in the female of *tentatrix*. Wings with typical nervation, but the apical crossvein straighter, the terminal stalk of the first posterior cell being therefore longer. Wing base bright yellowish to the basal and anal crossveins, but along the fore border the yellow colour is extended into

the costal and subcostal cells to the end of stigma, which is likewise yellow; along the first basal cell the yellow colour is extended to a little before the small crossvein. The broad hyaline stripes into the base of submarginal and of discoidal cell are whitish. The middle dark band is broad and entire, extending from the costa to the fifth vein; the whitish-hyaline band beyond it is as broad as the dark preapical band; the marginal cell is entirely black to the end; the submarginal cell is narrowly infuscated at the extreme end. The third posterior cell is almost entirely dark brown, with a whitish hyaline streak along the fifth vein. Alula entirely blackish to the base.

Subgenus EUTHEROPSIS T.T.

The characters on which this subgenus was founded are not of sufficient value to be considered as generic, inasmuch as the Ethiopian species here described differ from the type-species in degree of ciliation of the parafacialia. The latter species has no prominent mouth border, while in *mannii* the mouth border is as prominent as in the American species. All the species show the infuscation of the third posterior cell, as in *barbiellinii*, but less intensive and equally present in both sexes.

4. EUTHERA MANNII Mik. ♂, ♀.

See descriptions and figures of Mik, Brauer and Stein. Known only from Dalmatia and Asia Minor; but Dr. Villeneuve tells me that he knows the species from British East Africa and from Formosa.

5. EUTHERA TUCKERI, n. sp. ♂. Text-fig. 2, A.

Distinct from the preceding on account of its mouth border not being prominent and of the lower facial keel. Type ♂, a single, badly preserved specimen in the South African Museum, Cape Town, from Transvaal, Koopmuiden, 30th October, 1918, collected by Rev. W. E. Tucker and named in honour of its discoverer.

♂. Length of body 7 mm.; of wing 5.5 mm. Head entirely black, shining only on lower part of occiput and on peristomialia. Frons rather narrow at vertex, being there twice as broad as the small ocellar triangle, gradually broadened forwardly, being at antennae three times broader than at vertex; frontal stripe deep black, broader than one of the parafrontalia, these latter white dusted, very narrow on basal half, broadened on apical half, and at antennae about as broad as the stripe; bristles black, decussate; no orbitals, ocellar very thin. Face entirely black, with slight whitish dust, not or very little shining; middle keel sharp, straight in profile, mouth border not at all prominent, parafacialia white dusted, with scattered thin hairs, as broad as the anterior part of the parafrontalia. Antennae wanting. Palpi rather thin, entirely yellowish, proboscis dirty blackish. Thorax entirely black; the back is rather shining with whitish dust, but the pattern is not distinguishable; scutellum like back. All the bristles black; three presutural dorsocentral and two acrostichal, scutellum with two strong lateral, one discal before end, and seemingly with a pair of very thin diverging apical. Calypters bare, whitish hyaline, with a narrow white border; halteres with whitish stalk and with blackish knob. Abdomen cylindrical, thick, entirely black, rather shining, with slight whitish dust, which is denser at sides below; setulae and bristles black, the latter at sides of all segments, and in middle of hind border from the second segment to

the end; genitalia rounded, shining black, not prominent but open; sternites concealed. All the coxae and the legs of first pair entirely black; other legs wanting. Wings normal, bend of fourth vein angular but obtuse, the apical crossvein straight and less oblique, parallel with the hind crossvein, the stalk of the first posterior cell being about one-half the length of the apical crossvein. Wing base whitish-hyaline. Costal, subcostal and marginal cell entirely black;

Text-fig. 2. Wings of *Euthera*, enlarged.
A. *tuckeri*, n. sp.; B. *péringueyi*, n. sp.

first dark band broad and entire, extended equally from the second to the fifth vein, including the two crossveins and going a little beyond them. Preapical band a little narrower than the whitish-hyaline band before it, end of submarginal cell entirely filled with brown; infuscation of third posterior cell less intensive, extending across the terminal half of this cell and of the axillary cell, but evanescent in middle at wing border. Alula entirely black.

6. EUTHERA PÉRINGUEYI, n. sp. ♀. Text-fig. 2, B.

Closely allied with the preceding species, but distinct by the characters of the above key; it seems impossible that it may be the female of preceding species.

Type ♀, a solitary, well preserved specimen in my collection from Chabra, Congo, dedicated to the memory of the late Doctor L. Péringuey, whose contributions to South African Entomology are universally esteemed.

♀. Length of body 7 mm.; of wing 5.5 mm. Head black, but the sides of the ocellar plate, the facial ridges and the antennal grooves are distinctly yellowish. Occiput shining black, considerably swollen, white dusted below at sides. Frons about as broad as one eye; middle stripe deep black, narrower than one of the parafrontalia, ocellar plate and parafrontalia very shining, the latter white dusted in front. Frontal bristles decussate; two orbital, the first pair much smaller than the second; ocellar bristles well developed. Parafacialia narrowed below, white dusted, with only a few hairs on the upper part. Face yellowish above, remainder black, but clothed with slight whitish dust, middle keel straight and low, mouth border not at all prominent, peristomialia shining black. Antennae longer than the face, first joint reddish; second joint reddish-brown, twice as long as the first, with black hairs; third joint black, linear, distinctly broadened and

upcurved at end, two and a half times as long as the second joint; arista as long as the third antennal joint, entirely reddish, bare, thickened at base. Palpi deep black, rather short and clavate; proboscis short, dirty reddish. Thorax black, shining, the whitish dust forming three broad stripes on the presutural part of back, pleurae white dusted. Scutellum very characteristic, triangular, flat, obtuse at end, black with slight whitish dust, there are only two pairs of lateral bristles, no discal and no apical, only a few short setulae on disc. Calypters whitish, opaque, halteres with blackish knob. Abdomen as in preceding species, but distinctly, even if little, compressed; bristles more developed, chiefly the middle pair at hind border of second segment; sides of third segment somewhat reddish. Coxae blackish, all the femora reddish, those of hind pair with blackish stripes below; tibiae and tarsi entirely deep black, front tarsi distinctly thickened. Bend of fourth vein rounded, the apical crossvein rather long and more oblique than the hind crossvein, the terminal stalk of first posterior cell much shorter than the apical crossvein. Pattern as in the preceding species, but with the preapical dark band broader and more curved.

Subgenus MACREUTHERA, nov.

This new subgenus is characterized by the different form of head, which is narrower and higher than in the other species; by the very different frons of the female, lacking the orbital bristles; and by the decussate apical scutellar bristles. The mouth border is as prominent as in *mannii*, the female front tarsi are not distinctly thickened. The type species is more robust and of greater size than the others; the abdominal macrochaetae are strong; in wing pattern it agrees with the Old World species, while in the quite bare parafacialia it agrees with the American ones.

Type: The following new species, *E. skusei*.

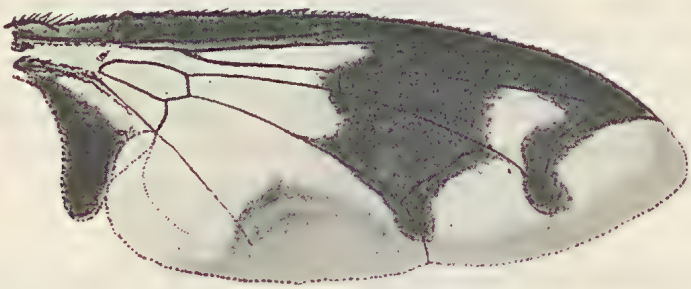
EUTHERA SKUSEI, n. sp. ♀. Text-fig. 3.

A robust species with reddish frontal stripe and with yellowish black-margined face.

Type ♀, a single specimen in the Health Department (New South Wales). Collection from Eidsvold, December, 1922. Dedicated to the memory of the great Australian Dipterologist, Frederick A. A. Skuse.

♀. Length of body 10 mm.; of antennae 2.8 mm.; of wing 8 mm. Head in front view as broad as high. Occiput black, white dusted at sides and below, and there with a reddish stripe along the hind border of the eyes; just above the neck there is a deep black stripe, extending to the reddish postvertical spot and narrowly margined with white dust; a row of black postocular bristles, and black hairs below. Frons broad and gradually widening forward; middle stripe parallel sided, bare, much broader than one of the parafrontalia, entirely reddish, except for a black spot on the ocelli, parafrontalia narrow, near the vertex half as broad as the middle stripe, broadened in front, black, white dusted. Frontal bristles short and thin, erect, not decussate, ending at base of antennae; orbital bristles quite absent; one pair of ocellar; inner vertical long and strong. In profile the frons is much more prominent than in the allied species; eyes narrow, with the vertical diameter twice as long as the horizontal one. Face long and narrower than in the allied species, with the middle keel rounded and very prominent, and with the antennal grooves almost parallel; it is yellowish in middle, margined with black at sides and below; parafacialia quite bare, narrow,

not broader than the third antennal joint, reddish, but densely clothed with whitish dust; mouth border very prominent and black. Peristomialia much broader than in the other species, as broad as one-third of vertical diameter of eye, dark reddish, with a blackish triangular spot just below the eye. Antennae long, porrect, longer than the face; first joint short, dark reddish, second joint more than twice as long as the first, dark reddish, with black setulae and with a long erect bristle above near the base; third joint black, three times as long as the second, linear in the basal half, dilated in the terminal half and ending



Text-fig. 3. Wings of *Euthera skusei*, n. sp., enlarged (same scale as preceding figures).

obtuse; arista basal, not longer than the third antennal joint, quite bare, thickened and yellowish at base, whitish and very thin in the rest. Palpi clavate, dark reddish, black haired; proboscis short, dirty brownish. Thorax entirely black, rather shining; on the back the whitish dust forming two broad stripes separated by a black one, continued in front of suture by two narrow lines, the sides are broadly dusted forming three broad and two narrow stripes on whole back; pleurae white dusted. All hairs and bristles black, dorsocentral numerous, but rather small, three to four behind and five in front of suture; acrostical two behind and three in front of suture; two sternopleural, four to five hypopleural, a tuft on upper border of pteropleura. Scutellum like back, rather convex, with two pairs of long lateral bristles, one pair discoidal, apical very thin and small, decussate. Calypters greatly developed, bare, whitish and with a white border; halteres with black knob. Abdomen entirely shining black, with whitish dust; hairs black; second segment with two strong macrochaetae in middle of hind border, third segment with four, fourth with a complete row. Sternites concealed. Coxae and legs entirely black; front tarsi not distinctly thickened; claws and pulvilli short. Wings normal, bend of fourth vein V-shaped, the apical crossvein concave; stalk of first posterior cell one-third the length of the apical crossvein; small crossvein a little beyond middle of discal cell; hind crossvein a little S-shaped. Base of wing whitish-hyaline to the small crossvein, and even beyond this vein into the base of submarginal cell; costal, subcostal and marginal cells entirely black; submarginal cell entirely black in its terminal half, quite destitute of the hyaline spot of all the other species. The broad middle band filling up the whole space between the two crossveins with irregular sides, ending below at fifth vein. The preapical band is formed only by a black margin of the apical crossvein, prolonged only a little beyond the band and there ending rounded. The infuscation of the third posterior cell is less intensive, slightly developed. Alula entirely black.

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THE COMBOYNE PLATEAU.

Its General Conformation and Flora.

By E. C. Chisholm, M.B., Ch.M.

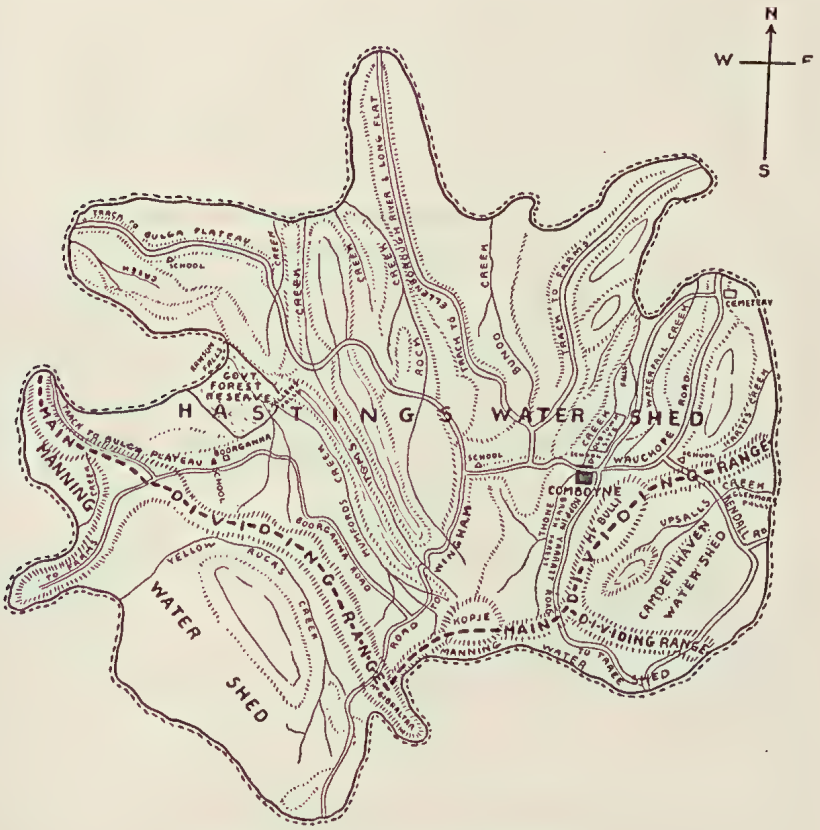
(One Text-figure.)

[Read 26th August, 1925.]

The Comboyne Plateau is situated in the County of Macquarie, about 170 miles north and a little east of Sydney, though 250 miles by rail and road, and about 20 miles by air line from the coast. Its average height above sea-level is 2,200 feet, though its highest point, Mount Gibraltar, rises to about 3,200 feet. There are two other mountains or high elevations, Mount Bulli, about 2,700 feet, and The Kopje, about 2,600 feet above sea-level. These three points occupy the south-east quadrant, and are situated near the edge, which falls away very abruptly in the case of Mount Gibraltar, less so in the other two cases. The rest of the Plateau is hilly, well intersected with perennial streams forming three watersheds. That on the east, taking its origin at the eastern base of Mount Bulli, is the watershed of the Camden Haven River, which, running through Kendall, reaches the sea at Laurieton; that on the south and south-west is the watershed of the Manning, which, lower down, runs through Wingham and Taree; that on the north, north-west and west forms the watershed of the Hastings, running out at Port Macquarie.

The area of the Plateau is estimated at about 70 square miles, the larger portion of it having been covered with Softwood Brush or Rain Forest. The formation is basaltic, the soil being of a rich red colour. This red soil reaches in places to a considerable depth, getting shallower towards the edges, especially to the north and west, where the formation is of sandstone or sedimentary deposit, and here, as one would expect, the hardwood timber, especially *Eucalyptus*, with a sprinkling of *Casuarina torulosa*, predominates. At the junction of the two formations it is usual to find *Tristania conferta* (the Brush Box). At isolated spots on the area, especially elevated ones, the sandstone—in using the term "sandstone" I am not confining myself to pure sandstone, of which there is very little, though it does occur in isolated patches—or sedimentary formation outcrops, and here again the hardwoods prevail. At the extreme summit of Mount Bulli one comes across *Eucalyptus quadrangulata*, this being the only place on the Comboyne where it is found, and the farthest north that it has been recorded, the Hunter River being its northern previously recorded limit (see Maiden, *Critical Revision, Genus Eucalyptus*, iii, p. 76). The country on top is now mostly cleared for dairying purposes, so that it is difficult to imagine this plateau in its virgin state. There is now only a comparatively small area of virgin brush forest left in the centre, though the Government has set apart 200 acres at the western edge, on Mumford's Creek, as a reserve, which area includes two fine waterfalls, the Allen Falls, not very high, but over which a large body of water is pre-

cipitated, and the Rawson Falls, the finest on the plateau, with a vertical drop in the first face of 270 feet, comprising a large body of water. This brush forest reserve has remained practically in its virgin beauty, except that the Red Cedar was removed years ago, and here there is a splendid assortment of softwoods with



Rough Map of the Comboyne Plateau.
E. C. Chisholm, del. Scale about ⅛ inch to 1 mile.

Elkhorns, Bird's Nest ferns and a host of climbing ferns, tree-ferns and palms. Hardwoods in the form of Brush Box, *Tristania conferta*, and Tallow Wood, *Eucalyptus microcorys* also are found here, with a sprinkling of *Eucalyptus saligna* (the Sydney Blue Gum).

The average annual rainfall recorded for the Plateau for the last 16 years is about 60 inches; the maximum in this period was 98.87 inches in 1921, and the minimum 42 inches in 1915. Last year (1924) 57 inches were recorded.

The history of the early settlement is interesting, but as this aspect is not the purpose of this paper, I will only allude to it briefly in passing. The earliest pioneers were two brothers O'Shaunessey, who arrived on the Plateau about 30 years ago. After remaining here for a time one of them died and the other, failing to get sympathetic encouragement from the Government, abandoned his selection and left the Plateau, and for some years no one ventured to take up land. About 25 years ago the present pioneer settlers arrived, mostly from the

South Coast of New South Wales—Robertson, Kangaroo Valley and neighbouring places—in several families, who, with Government encouragement, began clearing for permanent settlement. When the brush forests were cleared and planted with Paspalum the growth was phenomenal, due to the rich humus of decaying leaves having enriched the soil from time immemorial to a depth of several feet, having been replenished year by year while the forest was under natural conditions, but, once cleared, each year of grass cultivation gradually depleted this rich humus, which was not being replaced, until at the present time the soil has lost to a great extent its former value and requires the help of fertilizers to produce good crops or grass. Below is an analysis of the soil of a part that had 20 years or so ago been part of a brush forest, but since that time has been under Paspalum or other grasses.

There is no doubt that the Earthworm plays a large part in fertilizing the soil by bringing up earth from the deeper layers and depositing it at the surface, so replenishing the top soil. But for this factor the fertility of the soil of this plateau would be much less than it is, as the Earthworm here is very numerous. Cockchafer larvae, which are abundant, probably do a little in this direction also.

The following analysis of a sample of Comboyne soil was kindly carried out for me by Mr. Ronald White, B.Sc.:—

Specific Gravity (H_2O = 1) 4.7. (Ether used to determine Sp. Gr. and then calculated to water). Very slightly soluble in hot or cold water. Chocolate brown in colour. Probably of volcanic origin, igneous rock broken down by weathering.

Composition.

Iron as ferric oxide and carbonate	4.32%
Lime, Calcium Carbonate and Calcium Sulphate, Anhydrite	0.78%
Magnesium, as chloride	0.23%
Potassium, as chloride	0.01%
Sodium, chloride and sulphate	3.03%
Organic matter (Humus)	2.11%
Clayey and siliceous matter, with traces of aluminous earths and phosphates	89.52%
	100.00%

Examined bacteriologically, cultures on Agar and Gelatine gave colonies containing *Saccharomyces* (yeasts), *Streptococcus aureus* and an unidentified anaerobic bacillus. There was no appearance of the presence of any organism capable of nitrogen-fixation, to which fact any soil deficiencies might be due.

The Flora of the Plateau.

The Filicales are well represented. Of the Tree-ferns both *Dicksonia* and *Alsophila* are numerous. *Asplenium nidus* (Bird's Nest Fern) and *Platycerium bifurcatum*, especially the former, are prominent features of the Brush Forest, almost covering the trunks and branches of some of the forest trees. One of the favourite hosts of these is *Tarrietia actinophylla* (Stave Wood), trees of which are also generally covered with many climbing ferns and orchids. *Adiantum aethiopicum* (the common Maiden-hair) is quite rare, though other species of the genus are fairly plentiful, among them *A. formosum*, which seems to prefer rocky situations. Ground and climbing ferns are numerous.

The Pines are only represented on the Plateau by one species, *Callitris Macleayana* (Stringybark Pine or Port Macquarie Pine) which grows to fine proportions. *Araucaria Cunninghamii* (Moreton Bay Pine) is found between the Plateau and Kendall to the east.

There are only two Palms, *Archontophoenix Cunninghamiana* (Bangalow) and *Linospadix monostachyus* (Walking-stick Palm). *Livistona australis* (Cabbage Palm) is entirely absent, curiously enough, although represented well on the coast and also on the next plateau to the south-west, viz., the Bulga, about 10 miles away.

All the Araceae grow here, the most interesting species of which is *Typhonium Brownii*, an Arum, whose flower is large and striking, growing close to the ground and of a liver colour. It appears to favour the western end of the plateau.

The Liliaceae and Iridaceae are poorly represented, while the Orchidaceae are mostly of the genus *Dendrobium*, of which *D. speciosum* (Rock Lily) and others are found as epiphytes on the trunks and branches of numerous brush trees. I have never seen the former growing on rocks here, though smaller forms, e.g., *D. Kingianum*, are commonly found in rocky situations.

The remaining Monocotyledons, viz., Grasses, etc., I am not including amongst the flora recorded.

The only *Casuarina* is *C. torulosa* (Forest Oak), which grows on sandstone ridges, or sedimentary rock, mostly at the edges of the plateau.

The family Fagaceae is represented by *Fagus Moorei* (Negrohead Beech), which is extremely rare, although many trees were undoubtedly destroyed during clearing. This appears to be near its extreme limit south, though it has lately been recorded from Barrington Tops. Of the genus *Ficus* I have recorded three species; *F. stephanocarpa* is a rare form here; the other two, *F. rubiginosa* and *F. macrophylla*, Port Jackson and Moreton Bay Figs respectively, are fairly common in the brushes and grow to a good height.

The Proteaceae are very poorly represented. *Orites excelsa* is called here "Silky Oak," from the resemblance of the wood to that of *Grevillea robusta*, which does not occur so far south, nor, so far as I have been able to determine, does any species of the genus. This timber, *O. excelsa*, which is plentiful, is in fair demand for milling and used for much the same purposes as *Grevillea robusta*, being much in demand for cabinet work. *Stenocarpus salignus* (Red Silky Oak or Beef Wood) is uncommon on the plateau, but is in great demand for cabinet work, the timber being a rich red, beautifully figured. It is used about the coast for gun stocks. No Banksias occur here. *Hakea*, *Persoonia* and *Lomatia* occur, but in one or two species only. *Lambertia* is absent.

Santalaceae are represented by *Exocarpus cupressiformis* (Native Cherry) growing on sandstone or sedimentary rock, though I know of one very fine tree growing in the midst of brush timber and this is the largest tree of its kind I have seen.

I have so far only recorded two species of the family Loranthaceae, viz., *Phrygilanthus celastroides* growing on *Cryptocarya australis* (Moreton Bay Laurel) and *Daphnandra tenuipes* (Yellow Wood), and *Loranthus dictyophlebus* growing on *Cryptocarya australis* and *Doryphora sassafras*.

Codonocarpus attenuatus, of the family Phytolaccaceae, is a handsome tree, bearing bell-shaped fruit in clusters at the top of the tree and with a light delicate foliage.

Clematis, with two species, is fairly common, but *Ranunculus lappaceus* (Buttercup) is decidedly uncommon. *Legnephora Moorei*, a climber with large, ivy-shaped leaves, is fairly numerous, festooning the trees. Its fruit is a black

berry forming clusters resembling small bunches of grapes, and very like them in outward appearance. *Eupomatia laurina* occurs in the brushes. The foliage is intensely shiny and of a bright green.

Of the Monimiaceae, *Wilkiea macrophylla* is one of the "Native Plums," bearing black oval fruit in clusters. *Daphnandra tenuipes* and *Doryphora sassafras* are plentiful everywhere.

The Lauraceae are fairly well represented, and among them are some valuable timbers and handsome trees, *Cinnamomum Oliveri* and *C. virens*, "Black Sassafras" or "Cinnamon Laurels." The former especially is worthy of cultivation, having a fine canopy and good shade, with a nice appearance. *Litsea dealbata* is one of the so-called "Wild Plums," bearing oval black fruit. It is a shapely shrub with large leaves with well marked veins and silvery underside. This would be worth cultivating. *Litsea reticulata* (Scaly Beech) is used a good deal for cabinet work, as it is easily worked and the timber has a pretty figure, and for building purposes. *Cryptocarya glaucescens* (Nutmeg Laurel) is very abundant and *Cryptocarya australis* (Moreton Bay Laurel) is also plentiful and marked by its beautiful symmetry and thick foliage; both would make fine ornamental shrubs.

Passing to the Saxifragaceae, *Quintinia Sieberi* (Opossum Tree) grows in the brushes, especially near creeks, and attains fair proportions. *Anopteris Macleayanus* has a superficial resemblance to the Waratah.

The Pittosporaceae include *Pittosporum undulatum*, which is not plentiful and mostly found in the neighbourhood of creeks. *Hymenosporum flavum* is a plant well worthy of cultivation, bearing large yellow jasmine-shaped flowers with a fine perfume and large leaves, though of rather straggling habit.

The family Cunoniaceae is represented by several valuable species. *Schizomeria ovata* (White Ash) is a handsome tree with large leaf and bearing fruit to outward appearance like that of the Lilly Pilly. It is very little, if at all, used here as a timber. *Ceratopetalum apetalum* (Coach Wood), a very valuable timber, used a good deal in coach work and railway carriage building, grows plentifully in the brushes and to fine proportions. *C. gummiferum* (Christmas Bush) does not occur on the Plateau, though between here and the coast, on the road to Kendall, I have seen fine trees a foot in diameter at the butt and very tall. They occupied a narrow belt, but for some unknown reason the large trees seemed to be dying. *Geissois Benthami* (Leather Jacket) is used a good deal for milling purposes in much the same capacity as Coach Wood, though inferior to it. A peculiarity of this timber is that in certain patches the wood is of stony hardness and gritty, so that the expert axemen avoid it if possible, as they complain that it takes the edge off the axe more than any other timber. On a superficial inspection the timber resembles Coach Wood rather closely. *Ackama Muelleri* (Brush Corkwood) is plentiful in the brushes. *Callicoma serratifolia* is common along the course of creeks, but grows to no great size.

The Rosaceae are well represented by four species of *Rubus*, *R. parvifolius* alone growing on sandstone, the other three species in the brushes.

The Leguminosae, including the Acacias, are poorly represented, only seven of the latter being found, of which *A. juniperina*, *A. floribunda* and *A. decurrens* var. *mollis* are decidedly rare. The prevailing species are *A. melanoxylon*, *A. intertexta* and *A. binervata*. The two former, with *A. elongata*, do well on the basalt, *A. binervata* on sandstone or sedimentary rock. I have only come across one *Cassia*, viz., *C. sophera*. The only representative of *Daviesia* found here is *D. corymbosa* var. *arborea*, a very handsome tree, especially when in bloom,

flowering in great profusion and growing on the sandstone at the edge of the Plateau, especially on the northern side. *Gastrolobium Boormani* is fairly plentiful on the southern side. *Indigofera australis* is not plentiful and found mostly just below the edge. It is reputed poisonous to stock. *Kennedya* is represented by three species, only found on sandstone. There is a total absence of *Hardenbergia.*

The family Rutaceae is fairly represented. *Boronia* and *Eriostemon* are not found. *Bosistoa euodiformis* (Bone Wood), the vernacular name from the very light colour of the timber, is used a good deal in cabinet and ornamental work. It grows to a large-sized tree and is an inhabitant of the brushes. *Geijera salicifolia* is a handsome tree with dark green leaves and would make a fine ornamental tree under cultivation. *Zieria Smithii* is present as a small bush. *Acronychia laevis* is a very common species, bearing a profusion of white berries, superficially resembling the fruit of the Lilly Pilly, which are greatly sought after by the Top Knot fruit pigeon, *Lopholaimus antarcticus. A. Baueri* is not so plentiful.

The family Meliaceae is well represented, some of the species being very valuable for their timber. *Cedrela australis* (Red Cedar) is the most valuable of all, and has been cut out here for many years, with the exception of a few trees in inaccessible places. A few seedlings and small trees are still to be seen at the western end of the Plateau. *Melia Azedarach* (White Cedar) is decidedly rare; for a long time after my arrival here I was told there was no White Cedar growing on top, but after careful searching I located three or four trees. It seems to have no particular value as a timber tree. *Dysoxylum Fraseranum* (Rosewood) is a valuable timber, used in the mills for building purposes, mostly for lining walls and ceilings. It has a pretty figure and for this reason is used in ornamental work. It is rich red in colour and has a very pleasant prefume. *D. rufum* is plentiful, but of no value as a timber. *Synoum glandulosum* (Pencil Cedar) grows plentifully, but is more of a shrub than a tree, and as such would make a handsome ornamental tree under cultivation on account of its symmetrical shape and pretty foliage. It does not seem to have any particular uses as a timber. All of this family grow on the basalt, and are inhabitants of the brush forests.

Comesperma is the only genus of the family Polygalaceae found, and it grows on sandstone country at the edge.

Of the family Euphorbiaceae, *Breynia oblongifolia* is a handsome shrub bearing small fruit hanging under the leaves. *Baloghia lucida* (Brush Bloodwood) grows to a fair sized tree, and is chiefly interesting from the amount of reddish sap that runs out when an incision is made into the trunk. *Homalanthus populifolius* (Bleeding Heart Tree), the popular name being due to its heart-shaped leaves which at one stage assume a bright-red hue, is a handsome tree with large leaves and should be worth cultivating. It is fairly plentiful.

The family Celastraceae is represented by *Celastrus australis*, a climbing vine with bright green shining leaves, which when in fruit is covered with small orange-coloured berries, and *Denhamia pittosporoides*, a tree resembling *Elaeocarpus reticulatus* to some extent, though its fruit resembles that of *Pittosporum.*

Of the Sapindaceae, *Sarcopteryx stipitata* is chiefly remarkable for its bright red berries, which arrest the eye. *Dodonaea triquetra* grows on the sandstone or sedimentary rock.

Akania Hillii is the only representative of the Akanaceae. This has sharp thorny edges to the long narrow stiff leaf and bears a red berry.

Of the Rhamnaceae, *Emmenospermum alphitonioides* is a fine shapely tree with shiny green leaves and bearing a small white flower and small orange-coloured berries. It would make a good ornamental tree.

The family Vitaceae is represented by *Vitis hypoglauca*, which is very plentiful, festooning even the highest trees in the brushes, and *V. Baudiniana*, much less plentiful and occurring mostly at the southern and western edges of the Plateau. This does not seem to grow to the same proportions as *V. hypoglauca*, the trunks of whose vines attain a diameter of 7 or 8 inches, which, when cut into, exude, in great quantities, a watery juice made use of as a drink by bushmen when thirsty.

The family Elaeocarpaceae is represented by *Elaeocarpus* and *Sloanea*. Of the former genus I have only found *E. reticulatus* and it is not very plentiful, seeming to prefer the edges of brushes at the junction of basalt and sandstone or sedimentary strata. *Sloanea Woollsii* (Yellow Carrabeen) is a brushwood tree of some importance, used a good deal at the mill. One use to which it is put is the manufacture of broom handles. It is a tall tree with a curious buttress formation of the trunk as it rises from the ground, and generally triangular.

The family Malvaceae has two genera represented in *Sida* and *Hibiscus*. *H. heterophyllus*, a tall shrub, bears a large conspicuous white flower with a purple centre having a superficial resemblance to a Magnolia, and with a prickly stem, and is found only on the southern slopes of the mountain side.

The family Sterculiaceae is represented by three genera and four species. *Brachychiton acerifolius* (Flame Tree) is one of the glories of the brushes when in flower, which only happens once in three or four years, and at this time it sheds its leaves and the whole tree becomes one mass of bright red cup-shaped blossoms, forming a beautiful contrast to the dark green of the brush trees in the background. *Brachychiton populneus* (Kurrajong) is not seen on top, and I only know of one tree on the western side some distance down on junction strata. *Tarrietia actinophylla* (Stave Wood) is used for milling purposes. It is buttressed as it rises from the ground and is the host of numerous ferns, orchids and mosses, and is usually one of the most heavily laden of all. *Commerconia Fraseri*, called here "Kurrajong," has large angular leaves, somewhat resembling those of the Plane Tree, and medium-sized white flowers. It prefers the edge of the basalt.

There are two species of *Hibbertia*, *H. volubilis*, which is a twining and trailing vine with a large handsome yellow flower like a dog-rose, and *H. dentata*, like a smaller edition of the former with smaller flowers and also of climbing habit. These, especially the former, are numerous, though the first-named seems to prefer the basalt, while *H. dentata* grows more on the edge. These two are the only representatives of the Dilleniaceae.

Of the family Violaceae, the only species of *Viola* I have found is *V. hederacea*, and that mostly in moist situations, especially near streams.

One species only of Flacourtiaceae, *Streptothamnus Beckleri*, has been observed. It is a vine with ivy-shaped leaves and the flower in bud superficially resembles the Fuchsia, hanging on a long stalk.

I have only met with one species of *Passiflora*, viz., *P. alba*, with a white flower; I have cultivated this and it has made a handsome ornamental vine, bearing flowers and fruit freely. It is an introduced species, and is poisonous to stock.

Pimelea ligustrina is the only representative of the Thymeleaceae, and is found growing on sandstone formation.

The family Myrtaceae is mostly represented by *Eucalyptus* on the sandstone or sedimentary rock, *Eugenia* and *Tristania* on the basalt, or at the junction of the two. *Myrtus Beckleri*, a tree of small growth or shrub, would do well in a shrubbery, as it is a shapely species mostly found on basalt. *Eugenia Smithii* (Lilly Pilly), fairly plentiful on basalt, bears pinkish-white fruit in profusion; it is a tree well suited for ornamental purposes on account of its thick foliage and symmetry. *Eugenia corynantha* is called here "White Cherry," on account of its light-coloured wood; the fruit is pear-shaped, the smaller end distal and of a red colour and a fair size. *Eugenia cyanocarpa*, a Lilly Pilly with purplish fruit, resembles *E. Smithii*. *Syncarpia laurifolia* (Turpentine) only grows in a small area on the southern side of the Plateau, at the edge of a brush forest; it is used principally as a timber for wharf piles, being one of the few timbers which the *Teredo* will not attack. *Backhousia myrtifolia* grows along courses of creeks, often at the edge of the basalt. *Tristania conferta* (Brush Box) is a fine tree, growing to high dimensions and greatly valued as a hardwood, a large quantity passing through the mills. Its favourite situation seems to be at the junction of basalt and other formation at the edge of brush forests. As an ornamental tree it is well known about the suburbs of Sydney. *Tristania laurina*, a Water Gum, called erroneously here by many "Flooded Gum", is generally found in damp situations, especially along the courses of creeks, and the nearer it is to water the larger the tree grows, and the redder the timber becomes. It is valued for many purposes, one of which is the making of axe handles, but to get the most benefit from it by making the wood tougher, it is usual to let the timber lie under water for a week or so before fashioning it. *T. neriifolia* I have failed to find here, though I have often searched for it. Most of the species of *Eucalyptus* grow on the sandstone or sedimentary rock at the fringe of the Plateau, though several species grow in the brushes on the basalt, but probably in these cases the depth of the basalt is not great. They are never very numerous in the brushes, and this rather points to the fact that although many seeds must be shed, only a comparatively few survive; it is quite uncommon to find seedlings under trees. Along the courses of creeks, where one would expect the basalt capping to be thinner, there are magnificent specimens of *E. saligna*. I have recorded thirteen species for the Plateau; some are rare, and two are represented by single specimens. Around the base of the Plateau, within a radius of ten miles, I have recorded eight more. These occur on the lower lands approximating sea-level. Many of these are species found in the Picton district, which the surrounding country somewhat resembles. *E. Andrewsi*, called here "Messmate" and "White Top," is a species with a useful timber, a large quantity of which passes through the mills and is used for much the same purposes as Tallow Wood (*E. microcorys*), though inferior to it, the two timbers being much alike. The former is inclined to possess gum veins, while *E. microcorys* is free from them, and will stand a heavier strain. *E. Andrewsi* is only found on the southern edge of the Plateau, on the higher elevations, on sedimentary formation; it grows to a fair height with good girth, the trunk and main branches being covered with a rough bark resembling that of *E. piperita*, while the upper branches are smooth. *E. pilularis* (Blackbutt) is only found on the northern and eastern edges of the Plateau, growing on junction strata or sedimentary rock, and continues easterly to the coast; some very fine trees are to be seen along the road to Kendall. It does not seem to be so plentiful between the Plateau and Wauchope in a north-easterly direction, though nearer the coast and about Port Macquarie it is plentiful. This timber passes through the mills in large quantities, but being full of gum veins it is of not the same

value as Tallow Wood. *E. acmenioides* (White Mahogany) grows on sandstone all around the fringe of the Plateau and is very plentiful. It is not much used as a timber, and is considered worthless by the mills; it is good for fencing purposes. *E. microcorys* (Tallow Wood) is about the most useful hardwood timber of all, and in great demand at the mills. Being free of gum veins and durable, it has many uses. One peculiarity about the timber is its greasy nature, and for this reason it is largely used as flooring for dancing halls, and also to a great extent in bridge building and decking. It grows to a fine tall tree with a straight trunk, many trees having a diameter, a few feet from the butt, of 5 feet. This tree is found growing on basalt in the brush forests, and frequently at the junction of basalt and other strata, and also on the latter alone. It is fairly well distributed throughout the Plateau, though it has been very much thinned out in late years for milling purposes. *E. quadrangulata* (Black Box) is only found in a very limited area on the eastern side at a high elevation on the summit of Mount Bulli; a few seedlings have found their way to the lower levels, though these make poor growth on the red soil compared to those on higher ground on black soil. This tree has not been recorded previously further north than the Hunter River. Its timber is not considered of any particular value and is not used at the mills. It does not grow to any great size. *E. saligna* (Sydney Blue Gum or Flooded Gum) is a valuable timber and passes in fair quantity through the mills. The timber is of a red colour and used for wood-blocks and by wheelwrights and for shipbuilding purposes. In the neighbourhood of creeks at the edges of brush forests and on the basalt itself, especially if near running water, it grows to immense proportions. It is a smooth gum with a varying amount of rough bark at the butt, and is to be found growing all over the Plateau, though considerably thinned out in the centre, and found well distributed on the junction strata at the edge of the Plateau. *E. grandis* shows a considerable resemblance to *E. saligna*; the timber of the two species is much alike in colour, and the two forms are often confused, both going by the name of "Flooded Gum." I have gathered from timber men that one timber is more interlocked than the other, but the real distinction lies in the fruit, that of *E. saligna* having invariably three valves which are well exserted and straight, or slightly everted, while in that of *E. grandis* the valves are four, or frequently five, in number, less exserted and inverted and of a paler colour. The timber is used for much the same purposes as that of *E. saligna*. At the junction of basalt with other formations I have seen splendid specimens of this species, though it is not nearly as plentiful as *E. saligna*. The trunks of the two trees are almost identical in appearance, as is also the general shape of the tree and the foliage. *E. propinqua*, a Grey Gum, and the common Grey Gum here, grows only on the edges of the Plateau outside of the basalt, and is found on the lower levels in fair quantity, where it seems to do better, growing to larger proportions than on top; near sea-level about Kendall there are some fine trees. The timber is red, but little used here, probably on account of it being too far from the mills. The bark is shed in patches, the denuded surface acquiring a salmon tint, giving the trunk a remarkable appearance. The fruit of this species is small. *E. punctata*, a larger-fruited Grey Gum, is not found right on top, but below the edge of the Plateau on the mountain side, especially to the north and west. It has a red timber, very hard and remarkably like that of Ironbark, and has been passed as such on many occasions. However, on striking the timber with the blunt end of the axe the impact gives a dull sound and the axe does not rebound, as in the case of Ironbark, which gives a ringing note and a larger rebound. This is one of the many tests employed to distinguish

between the two. It is inferior to Ironbark, though looked upon as a very valuable timber and as a fairly efficient substitute; it has not the same tensile strength, and, moreover, contains many gum veins. It is used largely for railway sleepers and wood blocking. *E. canaliculata* is a Grey Gum with a large fruit and angulated pedicel. The fruit is larger and coarser than that of *E. punctata*, and the timber, instead of being red, as is the case with the latter, is yellow. There is one tree only known to me that answers to these characters, and it is growing on top of a hill which has been partially cleared and on basalt formation close to an existing brush forest. In appearance it is quite different from *E. punctata*, especially in regard to its bark, which is rougher and has not the same clean appearance. Moreover, a peculiarity that struck me was its manner of flowering. This takes place on the medium-sized stems close to the main trunk, about half way up the tree, and directly off these stems which are 3 inches or so in diameter. The size of the tree in question is not large, the height would be about 40 feet and the diameter of the trunk at the butt ten inches to a foot. *E. tereticornis* (Forest Red Gum) is found only at the edge of the Plateau and is not very plentiful, though much more so off the mountain in the surrounding low level land. This species is only found on the sandstone or sedimentary soil, frequently in the company of *E. propinqua* and, on the lower levels, of *E. amplifolia* and *E. paniculata*. It appears to have no particular value as a timber, the saw mills here not using it; the timber is red. I know of only one specimen of *E. amplifolia* (Broad-leaved Forest Red Gum), growing at the edge of brush at the junction of basalt and other strata, though in the surrounding country around the foot of the mountain it is very plentiful. The timber does not seem to be of any particular value, and it does not attain large proportions. *E. corymbosa* (Bloodwood) is plentiful outside the basalt all round the edge of the Plateau. As a timber it is not thought very much of on account of its numerous gum veins; it is used for posts and culverts, but is not used by the mills here.

Leptospermum flavescens is the only species of the genus recorded, and is not at all plentiful, being found mostly off the basalt. *Callistemon* is represented by a crimson-flowered form, *C. lanceolatus* var., growing on rugged country at the edge of pure basalt. *Melaleuca Leucadendron* grows towards the southern side of the Plateau, where there is a mixture of soils.

Two forms of the Araliaceae are represented: *Tieghemopanax Murrayi*, which grows in great profusion in the brushes, has a palm-like appearance with a leaf somewhat resembling that of the Red Cedar. There is a good deal of confusion as to the identity of this species; it commonly goes by the name of "Aralia." It belongs to the family Araliaceae, but is not the true *Aralia*, which does not grow here. This tree is interesting on account of the occurrence of two or three isolated individuals in the Jamieson Valley on the Blue Mountains, close to the track leading down the "Valley of the Waters" at Wentworth Falls. As it is essentially a North Coast form, one wonders how it found its way there. The other species is *T. sambucifolius*, which is fairly plentiful.

The family Epacridaceae is represented only by *Trochocarpa laurina*, a tree sometimes called here "Wild Cherry," from the fact that it bears small fruit, though with little resemblance to the Cherry, and a *Leucopogon*.

Sideroxylon australe (Black Apple), of the family Sapotaceae, is a tree inhabiting the brush forests, the fruit of which is large and of a coarse texture. It is plentiful.

Diospyros cargillia (Ebenaceae), one of the so-called "Black Plums," bearing a small egg-shaped black fruit with the calyx of the flower well represented at its base, is not plentiful.

Of the Apocynaceae, most are climbing forms. *Chilocarpus australis* is a vine which, growing up into the trees, festoons them and is interesting on account of its long oval salmon-coloured fruit of the same tint as a ripe persimmon. *Alyxia ruscifolius* is a low shrub with prickly leaves growing in whorls of three. *Lyonsia straminea* and *L. largiflorens* are creepers festooning the brush trees.

The family Asclepiadaceae is represented by *Marsdenia*, of which *M. rostrata* is the only one noted. This is interesting from the fact that in some districts it is under suspicion of being poisonous to stock, though not here as yet. I have found it in partially cleared paddocks used as grazing land for dairy cows.

Ehretia acuminata (Borraginaceae) is interesting from the fact of its being one of our few deciduous trees. On superficial inspection it bears a good deal of resemblance to the cultivated Cherry in its general shape and form of leaf. It bears a profusion of small yellow fruits. It is a brush tree, and plentiful.

Clerodendron tomentosum (Verbenaceae), an inhabitant of the brushes bearing a purple fruit surrounded by a fleshy collar, is not very plentiful. *Gmelina Leichhardtii* (White Beech), a very valuable timber, is much sought after as a softwood for the interior of houses, a large quantity passing through the mills. It grows to a fine tall tree, the trunk having a whitish appearance and the timber being light coloured. It is a typical brush tree.

The Labiatae are poorly represented. *Plectranthus parviflorus* is a small plant liking moist situations, bearing a spiked purple inflorescence. *Prostanthera ovalifolia* var. *latifolia* is a shrub bearing handsome purple flowers growing on mixed strata.

The Solanaceae are well represented in the genus *Solanum*, of which *S. opacum*, bearing small white flowers, is of small growth; *S. pungentium* is thorny and grows close to the ground with a large purple flower. The others, *S. simile*, *S. aviculare* and *S. verbascifolium* var. *auriculatum*, especially the last-named, are of much higher growth. They all bear fruit, mostly yellow or blackish in colour, and purple flowers. *S. pseudo-capsicum* is an introduced plant growing in great profusion here, having a white flower and orange-red berries. *S. verbascifolium* var. *auriculatum*, commonly called "Tobacco Plant" from the nature of its large leaf, has taken possession of many acres of the top after the areas have been cleared of the original brush. *Duboisia myoporoides*, known as "Cork Wood" on account of its rough bark, is also a feature of the cleared land, and grows into a medium-sized tree, bearing small white flowers. The leaves contain duboisine, consisting of a mixture of the alkaloids hyoscine and hyoscyamine, which is used as a mydriatic in ophthalmic practice.

The only representative of Bignoniaceae is *Tecoma australis*, which is a climber festooning the brush trees, and when bearing flowers is very handsome.

Eranthemum variabile, of the family Acanthaceae, is a small plant with a mauve-coloured flower.

Myoporum acuminatum is the only representative of the Myoporaceae, and is very rare. I only know of one tree on the Plateau. It would make a fine ornamental tree, being shapely, with dense foliage.

Turning to the Rubiaceae, *Morinda jasminoides* is a climber bearing small whitish flowers in profusion, the fruit being a small orange-coloured berry with a mosaic pattern dividing it into segments. *Psychotria loniceroides* is a small tree growing fairly plentifully in the brushes, having a leaf shaped somewhat after that of the Loquat, but softer in consistency.

Sambucus xanthocarpa (Native Elderberry) is fairly plentiful and is the only representative of the family Caprifoliaceae.

Melothria Cunninghamii is a climbing form of the Cucurbitaceae.

Members of the family Compositae are not numerous, being mostly of the genera *Helichrysum, Gnaphalium, Erechites, Senecio* and *Olearia.*

On reviewing this paper several interesting facts obtrude themselves. The entire absence of *Livistona australis* (the Cabbage Palm) which one would expect to occur here, since it inhabits basalt formation and is to be found 20 miles east on the coast and 10 miles south-west on the Bulga Plateau at an elevation as high or higher than this. One cannot help wondering why it has not gained a foothold on this plateau, and this is the more remarkable since the fruit forms a part of the food of several species of Fruit Pigeon which are abundant on both plateaux and migrate from one to the other. The absence of *Ceratopetalum gummiferum* is more easily explained, seeing that it grows almost entirely on sandstone. The small area of sandstone, comparatively speaking, on the plateau also accounts for the paucity of genera of the Proteaceae and Epacridaceae.

I have been on the look out for *Alphitonia excelsa* (Red Ash), which I have failed to find, and can get no information about it, so I am almost forced to the conclusion that it does not occur here. The genus *Flindersia* (The Teak and its allies) does not occur, nor does *Castanospermum australe* (Black Bean), their habitat being further north.

In conclusion I wish to record my grateful thanks to Mr. J. H. Maiden, late Director, and Dr. Darnell-Smith, the present Director of the Botanic Gardens, for affording me facilities for having the plants identified, and also to the staff of the National Herbarium, especially to Mr. W. F. Blakely, who has done most of the work and given me much information.

List of the Plants of the Comboyne Plateau.

Hymenophyllaceae: *Trichomanes venosum* R. Br.

Cyatheaceae: *Dicksonia Youngiae* C. Moore, *Alsophila australis* R. Br., *A. Cooperi* F.v.M., *A. Leichhardtiana* F.v.M.

Polypodiaceae: *Dryopteris decomposita* R. Br., *D. punctata* Thunb., *D. parasitica* (L.) O. Kuntze, *D. acuminata* Lowe, *Arthropteris Beckleri, A. tenella* Forst., *Davallia dubia* R. Br., *Athyrium umbrosum* Ait., *Asplenium nidus* L., *A. adiantoides* L., *Blechnum cartilagineum* Sw., *B. serrulatum* Rich., *B. Patersoni* R. Br., *B. discolor* Forst., *B. capense* (L.) Schlecht, *Doodia aspera* R. Br., *Pellaea falcata* R. Br., *Cheilanthes tenuifolia* Sw. var. *Sieberi* Benth., *Adiantum aethiopicum* L., *A. formosum* R. Br., *A. affine* Willd., *Pteris tremula* R. Br., *Histiopteris incisa* Thunb., *Pteridium aquilinum* L., *Polypodium Brownii* Wickstr., *P. diversifolium* Willd., *Cyclophorus confluens* R. Br., *Platycerium bifurcatum* Cav., *Pellaea paradoxica* (R. Br.).

Gleicheniaceae: *Gleichenia circinata* Sw., *G. flabellata* R. Br.

Osmundaceae: *Todea barbara* (L.) Moore.

Pinaceae: *Callitris Macleayana* F.v.M.

Potamogetonaceae: *Potamogeton tricarinatus* F.v.M.

Cyperaceae: *Gahnia aspera* Spreng., *G. psittacorum* Labill., *Lepidospermum concavum* R. Br.

Palmae: *Linospadix monostachyus* Wendl. and Drude, *Archontophoenix Cunninghamiana* Wendl. and Drude.

Araceae: *Typhonium Brownii* Schott., *Colocasia macrorrhiza* Schott., *Gymnostachys anceps* R. Br., *Pothos longipes* Schott.

Liliaceae: *Stypandra glauca* R. Br., *Xerotes longifolia* R. Br., *Xanthorrhoea resinosa* Pers., *Geitonoplesium cymosum* A. Cunn., *Eustrephus latifolius* R. Br., *Rhipogonum album* R. Br., *Smilax glycyphylla* Sm., *S. australis* R. Br.

Iridaceae: *Libertia paniculata* Spreng.

Orchidaceae: *Dendrobium speciosum* Sm., *D. Kingianum* Bidw., *D. pugioniforme* A. Cunn., *D. gracilicaule* F.v.M., *D. teretifolium* R. Br., *Bulbophyllum Shepherdi* F.v.M., *Spiranthes australis* Lindl.

Casuarineae: *Casuarina torulosa* Ait.

Fagaceae: *Fagus Moorei* F.v.M.

Moraceae: *Cudrania javanensis* Trec., *Ficus rubiginosa* Desf., *F. macrophylla* Desf., *F. stephanocarpa* Warb.

Urticaceae: *Urtica incisa* Poir., *Laportea gigas* Wedd.

Proteaceae: *Persoonia media* R. Br., *Helicia glabriflora* F.v.M., *Orites excelsa* R. Br., *Hakea saligna* R. Br., *Lomatia ilicifolia* R. Br., *Stenocarpus salignus* R. Br.

Santalaceae: *Exocarpus cupressiformis* Labill.

Loranthaceae: *Loranthus dictyophlebus* F.v.M., *Phrygilanthus celastroides* (Sieb.) Eichl.

Polygonaceae: *Polygonum hydropiper* L.

Phytolaccaceae: *Codonocarpus attenuatus* Hook.

Ranunculaceae: *Clematis aristata* R. Br., *C. glycinoides* DC., *Ranunculus lappaceus* Sm.

Menispermaceae: *Legnephora Moorei* Miers.

Magnoliaceae: *Drimys dipetala* F.v.M.

Anonaceae: *Eupomatia laurina* R. Br.

Monimiaceae: *Piptocalyx Moorei* Oliv., *Wilkiea macrophylla* A. DC., *Palmeria scandens* F.v.M., *Daphnandra tenuipes* Perk., *Doryphora sassafras* Endl.

Lauraceae: *Cinnamomum Oliveri* Bailey, *C. virens* R. T. Baker, *Litsea dealbata* Nees, *L. reticulata* Benth., *Cryptocarya glaucescens* R. Br., *C. australis* Benth.

Saxifragaceae: *Quintinia Sieberi* A. DC., *Anopteris Macleayanus* F.v.M.

Pittosporaceae: *Pittosporum undulatum* Andr., *Hymenosporum flavum* F.v.M., *Bursaria spinosa* Cav., *Billardiera scandens* Sm., *Citriobatus multiflorus* A. Cunn.

Cunoniaceae: *Aphanopetalum resinosum* Endl., *Geissois Benthami* F.v.M., *Ackama Muelleri* Benth., *Schizomeria ovata* D. Don, *Ceratopetalum apetalum* D. Don, *Weinmannia rubifolia* Benth., *Callicoma serratifolia* Andr.

Rosaceae: *Rubus moluccanus* L., *R. parvifolius* L., *R. rosaefolius* Sm., *R. Moorei* F.v.M., *Acaena ovina* A. Cunn.

Leguminosae: *Acacia elongata* DC., *A. melanoxylon* R. Br., *A. intertexta*, *A. binervata* DC., *A. longifolia* Willd., *A. floribunda* F.v.M., *A. decurrens* Willd. var. *mollis* Lindl., *A. juniperina* Willd., *Cassia sophera* L., *Daviesia corymbosa* Sm. var. *arborea* Maiden, *Gastrolobium Boormani* Maiden and Betche, *Indigofera australis* Willd., *Kennedya rubicunda* Vent., *K. prostrata* R. Br.

Geraniaceae: *Geranium dissectum* L., *Pelargonium inodorum* Willd.

Oxalidaceae: *Oxalis corniculata* L.

Rutaceae: *Bosistoa euodiformis* F.v.M., *Geijera salicifolia* Schott., *Evodia micrococca* F.v.M., *Zieria Smithii* Andr., *Acronychia laevis* R. and G. Forst., *A. Baueri* Schott.

Meliaceae: *Cedrela australis* F.v.M., *Melia Azedarach* L., *Dysoxylum Fraseranum* Benth., *D. rufum* Benth., *Synoum glandulosum* A. Juss.

Polygalaceae: *Comesperma ericinum* DC.

Euphorbiaceae: *Breynia oblongifolia* J. Muell., *Claoxylon australe* Baill., *Baloghia lucida* Endl., *Homalanthus populifolius* Grah.

Celastraceae: *Celastrus australis* Harv., *Denhamia pittosporoides* F.v.M.

Sapindaceae: *Diploglottis Cunninghamii* Hook., *Sarcopteryx stipitata* Radlk., *Nephelium leiocarpum* F.v.M., *Dodonaea triquetra* Wendl.

Akaniaceae: *Akania Hillii* Hook.

Rhamnaceae: *Emmenospermum alphitonioides* F.v.M.

Vitaceae: *Vitis Baudiniana* F.v.M., *V. hypoglauca* F.v.M.

Elaeocarpaceae: *Elaeocarpus reticulatus* Sm., *Sloanea Woollsii* F.v.M.

Malvaceae: *Sida rhombifolia* L., *Hibiscus heterophyllus* Vent.

Sterculiaceae: *Brachychiton acerifolius* F.v.M., *B. populneus* R. Br., *Tarrietia actinophylla* Bailey, *Commerconia Fraseri* J. Gay.

Dilleniaceae: *Hibbertia volubilis* Andr., *H. dentata* R. Br.

Violaceae: *Viola hederacea* Labill.

Flacourtiaceae: *Streptothamnus Beckleri* F.v.M.

Passifloraceae: *Passiflora alba* Link and Otto.

Thymeleaceae: *Pimelea ligustrina* Labill.

Myrtaceae: *Myrtus Beckleri* F.v.M., *Eugenia Smithii* Poir., *E. corynantha* F.v.M., *E. cyanocarpa* F.v.M., *Syncarpia laurifolia* Ten., *Backhousia myrtifolia* Hook and Harv., *Tristania conferta* R. Br., *T. laurina* R. Br., *Eucalyptus Andrewsi* Maiden, *E. pilularis* Sm., *E. acmenioides* Schau., *E. microcorys* F.v.M., *E. quadrangulata* Deane and Maiden, *E. saligna* Sm., *E. grandis* Maiden, *E. propinqua* Deane and Maiden, *E. punctata* DC., *E. canaliculata* Maiden, *E. tereticornis* Sm., *E. amplifolia* Naudin, *E. corymbosa* Sm., *Leptospermum flavescens* Sm., *Callistemon lanceolatus* DC. var., *Melaleuca Leucadendron* L.

Oenotheraceae: *Epilobium glabellum* G. Forst.

Araliaceae: *Tieghemopanax Murrayi* R. Viguier, *T. sambucifolius* R. Viguier.

Umbelliferae: *Hydrocotyle asiatica* L.

Epacridaceae: *Trochocarpa laurina* R. Br., *Leucopogon* sp.

Sapotaceae: *Sideroxylon australe* Benth. and Hook.

Ebenaceae: *Diospyros cargillia* F.v.M.

Gentianaceae: *Erythraea australis* R. Br.

Apocynaceae: *Chilocarpus australis* F.v.M., *Alyxia ruscifolius*, R. Br., *Lyonsia straminea* R. Br., *L. largiflorens* F.v.M.

Asclepiadaceae: *Marsdenia rostrata* R. Br.

Borraginaceae: *Ehretia acuminata* R. Br.

Verbenaceae: *Clerodendron tomentosum* R. Br., *Gmelina Leichhardtii* F.v.M.

Labiatae: *Plectranthus parviflorus* Henck., *Prostanthera ovalifolia* R. Br. var. *latifolia* Benth.

Solanaceae: *Solanum opacum* A. Br., *S. aviculare* G. Forst., *S. simile* F.v.M., *S. verbascifolium* L., var. *auriculatum* Ait., *S. pseudo-capsicum* L., *S. pungentium* R. Br., *Duboisia myoporoides* R. Br.

Bignoniaceae: *Tecoma australis* R. Br.

Acanthaceae: *Eranthemum variabile* R. Br.

Myoporaceae: *Myoporum acuminatum* R. Br.

Plantaginaceae: *Plantago varia* R. Br.

Rubiaceae: *Morinda jasminoides* A. Cunn., *Psychotria loniceroides* Sieb.

Caprifoliaceae: *Sambucus xanthocarpa* F.v.M.

Cucurbitaceae: *Melothria Cunninghamii* Benth.

Compositae: *Olearia dentata* Moench., *Helichrysum elatum* A. Cunn., *H. Beckleri* F.v.M., *H. diosmifolium* Don, *H. bracteatum* Willd., *H. ferrugineum* Less., *Gnaphalium japonicum* Thunb., *Erechites prenanthoides* DC., *Senecio dryadeus* Sieb., *Olearia ramulosa* Benth.

Additional Determinations.
(Added 26th August, 1925.)

Cycadaceae: *Macrozamia Perowskiana* Miq. Only one plant found; stem about eight inches in diameter.

Taxaceae: *Podocarpus elata* R. Br. Brown or She Pine; very rare.

NOTES ON SPECIES OF *PTEROSTYLIS*.

By Rev. H. M. R. Rupp, B.A.
(*Communicated by E. Cheel.*)

(Ten Text-figures.)

[Read 26th August, 1925.]

Including an undetermined Tasmanian form, and a doubtful New South Wales *P. striata*, my herbarium contains 32 species of these interesting terrestrial orchids. Dr. R. S. Rogers in his paper on the Distribution of Australian Orchids (*Trans. Roy. Soc. S.A.*, xlvii, 1923) gives 43 as the total number of determined Australian species. Maiden and Betche in their *Census of the Plants of N.S.W.* (1916) credit this State with 26, and, if specific rank be allowed to *P. squamata* R. Br. and *P. Mitchelli* Lindl., this number will be 28. I do not know whether other species have been added to New South Wales records since 1916, but of those in the *Census*, my collection lacks only Fitzgerald's *P. pedoglossa*, *P. clavigera*, *P. coccinea*, and *P. Woollsii*, and of these I am acquainted with the first- and last-named. Until very recently, I had no Queensland specimens, but through the kindness of Miss H. Geissmann, of Tambourine Mountain, this defect is being remedied. There are six species (plus the doubtful *P. striata*) from New South Wales localities only, two from Tasmania only, three from Western Australia only, and one, or possibly two (see note on *P. decurva*) from Victoria only. The remainder are from various localities in the above States and South Australia. For all my South Australian specimens I am indebted to Dr. R. S. Rogers, of Adelaide, and for Western Australian plants to Mrs. G. E. Perrin, of Launceston, and Dr. Rogers. In the locality records given below, the initials M.R. denote specimens collected by myself; in all other cases the collector's name is given. To Miss H. Geissman I am indebted for beautiful photographic studies of Tambourine Mountain plants which I regard as *P. curta* R. Br. (two forms), *P. Baptistii* Fitzg. (see note under this species and *P. acuminata*), *P. nutans* R. Br., *P. grandiflora* R. Br. (see note), *P. obtusa* R. Br., *P. decurva* Rogers (doubtful), *P. pedunculata*, R. Br., and *P. longifolia* R. Br.

1. P. ophioglossa R. Br.—This species shares with *P. concinna* the distinction of a "forked" labellum. In *P. concinna* the lobes or prongs are short and blunt, in *P. ophioglossa* they are long and fine-pointed, hence the name. I have recorded this species from Copmanhurst, N.S.W., and recently received a specimen from Mrs. G. Annand, of Lismore, Richmond River. The flower is usually much larger than that of *P. concinna*, which it resembles, but the fine points of the lower lip are more curved.

Herbarium localities: Near Smith's Lake, Bungwahl (Myall Lakes), July, 1924 (A. Rupp and M.R.), Paterson, June, 1925 (M.R.)—a form with beautiful crimson striae on a translucent-greyish flower.

Range of species: Eastern Victoria (?) through N.S.W. into Queensland, at least as far north as Port Curtis. Chiefly in the coastal areas.

2. P. CONCINNA R. Br.—The flowers are a duller green than those of *P. ophioglossa*, with darker striae. The long points of the lateral sepals are typically very straight.

Sandringham-Black Rock, Vic., Aug., 1897, and Sept., 1922 (M.R.), Cheltenham, Vic., June, 1915 (Dr. and Mrs. R. S. Rogers), Lane Cove, N.S.W., July, 1919 (M.R.), Lindisfarne, Tas., July, 1920 (M.R.), Bungwahl, N.S.W., June, 1924 (M.R.).

Range: All States of the Commonwealth, except Western Australia, chiefly coastal and often littoral.

3. P. CURTA R. Br.—Maiden and Betche record two forms, one as var. *grandiflora* (Bentham). I have collected what I take to be two distinct forms both in New South Wales and Tasmania, but have always regarded the larger and handsomer as the type, and the other—far less common—as a variety. Miss Geissmann has sent photographs, with the vernacular name "Swallow-tail", of flowers apparently identical with the small form. She states that it blooms much earlier than the other; in the Bulladelah district of New South Wales it is rather more than a month earlier. Miss Geissmann informs me that Dr. Rogers was of opinion that it was a hybrid *P. curta* × *P. pedunculata*. I have not observed any indications of the latter as a possible parent, and should have expected a darker flower, whereas it is always a lighter green than the typical *P. curta*, with which it seems to agree in essential characteristics. In Victoria I have only seen the larger form. In Bailey's *Queensland Flora* the author notes a doubtful var. *grandiflora* with flowers more than 2 inches long, the lobes of the lower lip ending in long points. I rather suspect that this is really *P. Baptistii* Fitzg. A true *P. curta*, however, should be distinguishable by the peculiar twist of the brown labellum in the mature flower, for observation of which fresh specimens are necessary. It is present in the small form above referred to.

Wannon River Falls, Vic., Aug., 1893 (M.R.), National Park, S.A., Aug., 1909 (Dr. and Mrs. R. S. Rogers), Bellerive, Tas., Sept., 1920 (M.R.), Low Head, Tas., Oct., 1921 (Mrs. G. E. Perrin and M.R.), Launceston, Tas., Oct., 1922 (M.R.), Bulladelah District, N.S.W., early July (small form) and Aug. (large form), 1923 (M.R.).

Range: All States except Western Australia, extending to the interior slopes of the Dividing Range in Victoria and New South Wales.

4. P. ACUMINATA R. Br.—Moore and Betche (*Handbook of the Flora of N.S.W.*) describe the dorsal sepal or galea as much incurved. I do not think this is a constant characteristic, as I have not infrequently found it comparatively straight from the main curve of the flower. Miss Geissmann sends photographs under this name from Tambourine Mountain, Queensland, but her plant appears to me beyond doubt identical with the much larger and handsomer *P. Baptistii* Fitzg. I sent Miss Geissmann dried specimens of the latter, and she concurs in the above opinion. Moreover, her description of the habitat of the Tambourine flower agrees with that usually characteristic of *P. Baptistii* rather than with that of *P. acuminata*, which in my experience (New South Wales and Victoria) occurs chiefly in sandy scrubs and heathland, not in rich mountain gullies or about sheltered forest creeks. In general appearance *P. acuminata* resembles *P. curta*, but is easily distinguished by the acuminate sepal-points and the green, non-twisted labellum.

Parramatta River, N.S.W., May, 1916 (M.R.), Lane Cove, N.S.W., April, 1918 (M.R.), Bungwahl, N.S.W., June, 1924 (M.R.), coastal moors, near south end of Moreton Bay, Q. (Miss H. Geissmann). (The Tambourine Mountain plant flowers in September.)

Range: Victoria, New South Wales, and Queensland. Bailey (*Queensland Flora*) says the lobes of the lower lips are produced into "long fine points". I have invariably observed them to be comparatively short, though acuminate.

5. P. BAPTISTII Fitzg.—Probably the largest of all species in this genus. I have measured flowers 3 inches from base to tip of galea. The plant may reach as much as 2 feet 6 inches in height, but is also frequently quite dwarf. Until I resided in the Bulladelah district, I had only seen this plant in the dried state in the National Herbarium at Sydney. I found in great abundance in that district in 1923 a very large *Pterostylis* which appeared to be identical with Fitzgerald's plant, except that only in rare cases were the stem-leaves strongly developed. The National Herbarium authorities, however, confirmed my determination, and Dr. R. S. Rogers expressed the opinion that the plant was undoubtedly *P. Baptistii*. The first appearance of this orchid above ground gives no hint of its subsequent development. The basal rosette is comparatively small, and in early stages the plant is not easily distinguished from *P. pedunculata*, the rosette-leaves of both being rather dark green, and much crisped along the margins. Yet one developes the largest, and the other one of the smallest, of the flowers in the genus. Herbarium specimens give no conception of the grace and beauty of the mature *P. Baptistii*, with its stately poise, and its harmonies of translucent-white, brown, and green. As mentioned above, Miss H. Geissmann has sent photographs of a Tambourine orchid which I have no hesitation in identifying with the plant so abundant at Bulladelah. Dr. H. L. Kesteven of the latter place found a specimen with two flowers perfectly developed, but rather under the average in size; it is now in my herbarium.

The Bulladelah-Myall Lakes district is my only herbarium locality at present, and numerous specimens were collected in Sept., 1923, and Sept., 1924.

Range of species: Imperfectly known; probably from about the N.S.W. National Park, northward along the coastal forests well into Queensland.

6. P. FURCATA R. Br. (Text-fig. 1).—Many years ago I found a colony of Pterostyles with very large flowers, green with darker longitudinal bands, in a gully on the slopes of Mount Buninyong, Vic. At the time they appeared to me to agree fairly with the description of *P. cucullata* R. Br., and for years they were so labelled. Subsequently I was disposed to doubt this determination; and when I first saw dried specimens of *P. Baptistii*, I wondered whether I had not discovered a form of that species a very long way beyond its supposed limits. During a residence in Tasmania from 1920-1923, I found two Pterostyles which appeared to me obviously distinct species, but which both passed under the name *P. cucullata*; the larger of the two much resembled the Buninyong orchid, except that it was more slender and had narrower and more stalked leaves. Mr. J. H. Maiden agreed that they certainly seemed distinct species. The larger he suggested as *P. cucullata*, and he thought that the other might prove to be what Robert Brown had called *P. dubia*. But in 1923, I sent specimens of the two Tasmanian plants and the Buninyong plant to Dr. Rogers for examination. He replied that in his opinion the Buninyong orchid was a form of *P. furcata*, though not typical; the smaller Tasmanian was a typical *P. cucullata*, and the larger one, *P. falcata* Rogers. This was satisfactory save for one point. I had Tasmanian specimens which I had labelled *P. furcata*, but they were

clearly not identical with the Buninyong specimens. I sent one to Dr. Rogers, but he was unable to determine it. This latter is described below as an undetermined species.

Mount Buninyong, Vic., Nov., 1896 (M.R.).

Range: Victoria, Tasmania, and South Australia. I have a single flower, without leaves, etc., from Mt. Kosciusko, N.S.W., which resembles Dr. Rogers's figure of *P. furcata*.

1. *Pterostylis furcata* R. Br. Mt. Buninyong, Vic. × ½.
2. *Pterostylis falcata* Rogers. Mt. Barrow, Tas. × ½ approx.

7. P. FALCATA Rogers (Text-fig. 2).—See above, under *P. furcata*. Dr. Rogers has described and figured this species (*Proc. Roy. Soc. Vict.* xxviii (N.S.), Part I). It appears to be common in the colder parts of Tasmania. Mrs. G. E. Perrin collected numerous specimens in the western highlands (Mt. Pelion, Mt. Ossa, etc.), Jan., 1922. In bogs among the foothills of Mt. Barrow I found many with larger flowers than Dr. Rogers has shown. It is a very graceful and handsome species, but lacks the rich brown markings of *P. Baptistii*, which it approaches in size.

Mount Barrow, Tas., Jan., 1922 (M.R.).

Range: Tasmania, Victoria, and probably New South Wales. Mr. R. H. Dowe, of Tamworth, has described to me an orchid which he found on the higher slopes of the New England tableland, which I think is very likely this species.

8. P. SP. ? (Text-fig. 3).—This is the plant referred to under *P. furcata* as an undetermined Tasmanian species. Dr. Rogers suggested that it might be a hybrid. Its abundance and wide distribution seem to me against its being so

regarded. I found it in abundance in the gullies of Mount Nelson and Mount Wellington in the south, and at Cataract Gorge in the north; on Mount Barrow I found numerous plants in fruit which seemed identical. The only other Pterostyles associated with it were *P. nutans* and *P. obtusa* (or *decurva*, see below), and beyond the generic characters it has no resemblance to either. It seems to have affinities with *P. cucullata*, but lacks the robust leaf development of that species, and the point of the galea is not similar. Comparing it with Dr. Rogers's figure of *P. furcata*, it is typically taller (the Cataract Gorge plants were small, but were growing on an exposed ledge of rock under a she-oak), with a smaller flower, and a longer space between the latter and the first bract. The length of the lateral sepals is about the same as in *P. acuminata*. The flower is almost wholly green, but turns rather a dark-brown when dried.

Mount Nelson, Tas., Oct., 1920 (M.R.), Cascades, near Hobart, Oct., 1920 (M.R.), Cataract Gorge, Launceston, Oct., 1922 (M.R.).

Range: Tasmania.

9. P. CUCULLATA R. Br.—This species also is described and figured in Dr. Rogers's paper alluded to above. For many years I had specimens collected on the banks of Merri Merri Creek, near North Coburg, Vic., labelled *P. Mackibboni* F.v.M., but Dr. Rogers has shown that this is really a form of *P. cucullata*. The typical form I did not see until I found it in Tasmania. The species is an interesting one, owing to its variations. It may reach a foot in height, with a remarkable development of stem-leaves; on the other hand the leaves may be all basal, with the flower on a stalk not more than an inch long. The "hood" of the flower is most frequently greatly incurved like a parrot's beak, but the flower itself is upright and not bent over like *P. nutans*, the "Parrot's Beak" of popular designation. Rich dark-brown markings often make it a very attractive flower, but they are not a constant feature.

Merri Merri Creek, Vic., Sept., 1897 (M.R.), Cherry Gardens, S.A., Sept., 1915 (Dr. and Mrs. R. S. Rogers), Mount Wellington, Tas. (at about 3,500 feet), Nov., 1920 (M.R.).

Range: Recorded from all States except Queensland and Western Australia, but the confusion with *P. falcata*, mentioned above under *P. furcata*, should be remembered.

10. P. NUTANS R. Br.—Probably the commonest of all our Pterostyles, and widely familiar under the name of "Parrot's Beak." Near Launceston I found a colony of this species which in two successive years came into bloom a month after the general flowering time was over; but beyond unusual slenderness I could find no variation from the type. In the Bulladelah district a distinct variety occurs, flowering at least a month earlier than the type. It has a diminutive flower with a very short galea, and the labellum is more hispid than usual. It is probably the var. *hispidula*. Miss Geissmann reports what appears to be an identical form from Tambourine Mountain, Q. At Bulladelah I found a few weird teratological specimens which are now in the possession of Dr. R. S. Rogers.

Bream Creek, Geelong, Vic., Oct., 1891 (M.R.), Kuitpo Reserve, S.A., Oct., 1906 (Dr. and Mrs. R. S. Rogers), Ryde, N.S.W., July, 1916 (M.R.), Hobart, Tas., Aug., 1920 (M.R.), Bulladelah, N.S.W., May, 1924 (var. *hispidula*), and July, 1924 (M.R.). Also other localities.

Range: All States except Western Australia.

11. P. PEDUNCULATA R. Br.—The resemblance of the basal rosette to that of *P. Baptistii* in the young plants has been noted above. In the southern States, including Tasmania, there appears to be but one form of this species, with a

flower slightly bulging below, translucent-white marked with red-brown. In New South Wales this type occurs, but there is another, usually taller, with a very small narrow flower almost wholly red-brown. The two are very distinct when

3. *Pterostylis* sp. Mt. Nelson, Tas. × ½.
4. *Pterostylis pyramidalis* Lindl. Jarnadup, W.A. × ½.
5. *Pterostylis decurva* Rogers. Lower Fern Tree Gully, Vic. × ½ approx.
6. *Pterostylis grandiflora* R. Br. Bulladelah, N.S.W. × ½.

seen together; both grew in the Bulladelah district. Miss Geissmann's Queensland photograph looks like the smaller-flowered form. In one of the Mount Wellington gullies in Tasmania I obtained a specimen bearing two flowers.

Sandringham, Vic., Oct., 1896 (M.R.), Balhannah, S.A., Sept., 1918 (Dr. and Mrs. R. S. Rogers), Mt. Wellington, Tas., Oct., 1920 (M.R.), Launceston, Tas., Oct., 1921 (M.R.), Bulladelah, N.S.W., Sept. and Oct., 1923 (M.R.), Paterson, N.S.W., Oct., 1924 (M.R.).

Range: All States except Western Australia.

12. P. NANA R. Br.—This dainty and diminutive species is sometimes found in colonies so dense that the plants might be plucked up by the handful. Chiefly littoral, but not exclusively so.

Sandringham, Vic., Oct., 1896 (M.R.), National Park, S.A., July, 1912 (Dr. and Mrs. R. S. Rogers), Westbury Road, Launceston, Tas., Sept., 1921 (M.R.), George Town, Tas., Oct., 1921 (Mrs. G. E. Perrin and M.R.).

Range: All States except Queensland.

13. P. PYRAMIDALIS Lindley (Text-fig. 4).—Flower resembling that of *P. nana*, but larger. It differs markedly from that species in its strongly developed, ovate-lanceolate stem leaves, and in the absence of a basal rosette.

Jarnadup, W.A., Sept., 1919 (Dr. and Mrs. R. S. Rogers), Margaret River, W.A., Sept., 1922 (Mrs. G. E. Perrin).

Range: Western Australia only.

14. P. ALATA Reichb. f. (= *P. praecox* Lindl.).—It might occasionally be mistaken for *P. obtusa*, but is quite distinct. The flower is greyish, with green or red-brown bands. Lower lip with a very broad sinus, the long, finely-pointed lobes either embracing the galea or sometimes extending out in front of it. Stem from 4 to 8 inches, the stem-leaves increasingly bract-like from above downwards.

Kangaroo Island, S.A., July, 1909 (Dr. and Mrs. R. S. Rogers), Bellerive, Tas., Sept., 1920 (M.R.), Launceston, Tas., Aug., 1922 (M.R.), Cape Barren I., Bass Straits, July, 1923 (Archdeacon Atkinson).

Range: All States except Queensland and Western Australia.

15. P. STRIATA Fitzg.—I have provisionally so labelled three specimens collected on the Nandewar Range, west of Barraba, N.S.W. They were growing in association with *P. reflexa* and *P. truncata*. They have a general resemblance to *P. obtusa*, but the labellum is narrow-linear and rather acute, and there is no projection at the sinus of the lower lip, which is a pronounced feature in *P. obtusa*. The galea is acuminate, the upper petals are rather blunt. Flower about 1 inch long, banded with red-brown and narrower green striae. Stem-leaves all approximately similar.

Nandewar Range west of Barraba, N.S.W., April, 1914 (M.R.).

Range: New South Wales.

16. P. OBTUSA R. Br. and 17. P. DECURVA Rogers (Text-fig. 5).—For the purpose of these notes these two species are dealt with together. For many years I had a specimen labelled *P. obtusa?* which I obtained near Lower Fern Tree Gully, Vic., in November, 1897. The doubt was due partly to the unusual elongation of the galea, and partly to the time of flowering. I collected numerous specimens of the Tasmanian *P. obtusa* which appeared to agree with the Victorian plant in both these points. In 1923, I found *P. obtusa* growing freely on the Alum Mountain, Bulladelah, flowering in the autumn. In every case the galea was merely acuminate, with no long decurved point. Dr. R. S. Rogers (*Trans. Roy. Soc. S. Aust.* xlvii, 1923) described a new species, *P. decurva*, from Lower Fern Tree Gully, Vic., and sent me a specimen collected by Mr. E. E. Pescott in that locality in November, 1923. Comparing my own plant from the same locality, collected twenty-six years before, there could be no doubt of their identity; and this raised the further question whether the Tasmanian plant supposed to be *P. obtusa* might not prove to be really *P. decurva*. Dr. Rogers sent me South Australian specimens of *P. obtusa* which were autumn-flowering, and agreed precisely with the Bulladelah plants. More recently Miss Geissmann has sent Queensland specimens, collected in May, 1925, which are identical with the Bulladelah and South Australian plants, except that the flowers are larger and the stem-leaves are more strongly developed. But with them Miss Geissmann sent two smaller specimens which she regards as distinct, and which (except that here also the stem-leaves are very prominent) appear identical with the Victorian

P. decurva and the Tasmanian supposed *P. obtusa*. Dr. Rogers writes to say that he is disposed to agree that the Tasmanian plant is really *P. decurva*, not *P. obtusa*; but further investigation is desirable. And if Miss Geissmann's smaller Queensland plants are *P. decurva*, we have the two forms flowering simultaneously on Tambourine Mountain in the autumn. It might be suggested that *P. decurva* is a variation from *P. obtusa* originating in the north, gradually altering its flowering-time as it spread southward, until in Tasmania it has become distinctly a summer flower (Nov.-Jan.). I do not know whether the typical *P. obtusa*, with a short galea, occurs in Tasmania at all. My numerous specimens were collected on Mounts Nelson and Wellington in the south, and Mount Barrow in the north, and in every instance they have a long decurved galea. In this form the fine points of the lower sepals are curved outwards after embracing the galea (Miss Geissmann calls attention to this in the Tambourine plants); in the typical *P. obtusa* they are usually approximately straight. Until fuller investigation has settled the distinction between these forms all my specimens are included with the long decurved galea under *P. decurva*, confining the name *P. obtusa* to those with a merely acuminate galea. Dr. Rogers does not think that Miss Geissmann's smaller plant is identical with *P. decurva*, but here also further investigation is required.

Localities.—P. obtusa: Hindmarsh Valley, S.A., April, 1912 (Dr. and Mrs. R. S. Rogers), Bulladelah, N.S.W., May, 1923 (M.R.), Tambourine Mt., Q., May, 1925 (Miss H. Geissmann). *P. decurva*: Lower Fern Tree Gully, Vic., Nov., 1897 (M.R.), and Nov., 1923 (E. E. Pescott, per Dr. R. S. Rogers), Mt. Nelson, Tas., Nov., 1920 (M.R.), Mt. Wellington, Tas., Dec., 1920 (M.R.), Mt. Barrow, Tas., Jan., 1922 (M.R.), Tambourine Mt., Q., May, 1925 (Miss H. Geissmann).

Range: *P. obtusa*, all States except Western Australia (Tasmania doubtful); *P. decurva*, all States except Western Australia (?).

18. P. RECURVA Benth.—A most remarkable looking flower, almost having the appearance of being "turned inside out." According to Dr. Rogers, the plant may attain a height of 20 inches. Stem-leaves numerous; lying rather close to the stem but not appressed. Flower about an inch long, banded longitudinally "dark greenish-grey" (Rogers). Lower lip with an acute sinus, the lobes not touching the galea, but recurved right away from it. Galea considerably shorter than lower lip, abruptly recurved, the petals very distinct from it, short, their points just meeting round the galea.

Woogenellup, Stirling Ranges, W.A., Sept., 1919 (Dr. and Mrs. R. S. Rogers), Mount Barker, W.A., Sept., 1922 (Mrs. G. E. Perrin).

Range: Western Australia only.

19. P. REFLEXA R. Br.—Somewhat similar in habit to *P. obtusa*, but the flower usually considerably larger. In New South Wales the highland forms seem to have consistently larger flowers than those on the coast. There appears to be a good deal of difference between forms included under this name. In some, the lower portion of the flower is extremely broad in proportion, and the points of the sepals, though fine, are comparatively short. In others, the flower is slender and the sepal-points are very long.

Nandewar Range, N.S.W., April, 1914 (M.R.), National Park, S.A., May, 1918 (Dr. and Mrs. R. S. Rogers), Warrabah, near Barraba, N.S.W., May, 1924 (R. H. Dowe), Bungwahl, N.S.W., June, 1924 (M.R.).

Range: Dr. Rogers reports it from all States. It is not in the *Flora of Tasamnia*, but of course may have been found there subsequently.

20. P. TRUNCATA Fitzg.—I found this in association with *P. reflexa* and the doubtful *P. striata* at about 3,000 feet on the Nandewar Range, N.S.W. It was at first determined for me as *P. praecox*, but subsequent familiarity with that species (= *P. alata*) showed it to be a very different plant. The Nandewar orchid seemed to me to agree with descriptions of Fitzgerald's *P. truncata*, and as Dr. Rogers concurred in this opinion I have retained it. The flower is almost twice as large as that of *P. alata*, on a very short stem of 1 to 2½ inches. Stem-leaves several, expanded or almost appressed. Flower banded with dark-green or reddish-brown striae; galea acuminate, upper petals bluntly truncate. Points of the lateral sepals extending far above the galea, hooked at the tips in all my specimens.

Nandewar Range, N.S.W., April, 1914 (M.R.).

Range: New South Wales and Victoria.

21. P. GRANDIFLORA R. Br. (Text-fig. 6).—The graceful lines of the flower crowning the prominent stem-leaves are very attractive, and the upper petals and galea are broadly expanded to form a rich red-brown hood, the rest of the flower being banded with the same colour against translucent-white. The basal rosette is usually withered before flowering time. The stem-leaves are developed with the longest one about the middle. Miss H. Geissmann sends a photograph of *P. grandiflora* from Tambourine Mountain, Q.

Lane Cove, N.S.W., June, 1917 (M.R.), Bulladelah, N.S.W., May and July, 1924 (M.R.).

Range: New South Wales and Southern Queensland.

22. P. PARVIFLORA R. Br.—In contrast with the last, this is probably the least attractive of all the Pterostyles (*P. aphylla* Lindl. included). The basal rosette may sometimes be present during flowering, but is not attached to the flowering stem. (This is true of some other species also—*P. grandiflora*, *P. obtusa*, *P. longifolia*—but in these cases it is unusual for the rosette to be present at flowering time. This seems to be the only real distinction between the typical *P. parviflora* and the form *aphylla*; the rosette of the latter disappears before flowering.)

Buninyong, Vic., May, 1896 (M.R.), Mt. Compass, S.A., April, 1915 (Dr. and Mrs. R. S. Rogers), Capertee, N.S.W., April, 1917 (M.R.), Lane Cove, N.S.W., June, 1917 (M.R.).

Range: All States except Western Australia.

23. P. BARBATA Lindl.—A peculiar and striking flower; from a few inches in height, and slender, to a robust plant of nearly 18 inches. Leaves crowded at the base but not rosulate, extending up the stem gradually as appressed bracts. Flower very upright, pale green, except the labellum; upper petals and galea appearing as if one segment. Labellum much exserted, often curved down, apparently by the weight of the brown knob at the end; filiform with many bright yellow hairs. Lower lip sharply decurved away from the upper; points of its lobes hardly acute.

Ringwood, Vic., Oct., 1896 (M.R.), The Hermitage, S.A., Sept., 1913 (Dr. and Mrs. R. S. Rogers), Kangaroo Valley, Hobart, Oct., 1920 (M.R.), Launceston and Low Head, Tas., Oct., 1921 (Mrs. G. E. Perrin and M.R.), Grampians, Vic., Oct., 1922 (Mrs. G. E. Perrin).

Range: All States except Queensland. I do not think it comes far north in New South Wales.

24. P. TURFOSA Lindl.—Obviously very closely allied to *P. barbata*, but more slender, less leafy, and the galea and lobes of the lower lip are produced into very long fine points—the latter not decurved sharply as in *P. barbata*. Labellum similar.

Upper King River, W.A., Sept., 1919 (Dr. and Mrs. R. S. Rogers), Albany, W.A., Sept., 1922 (Mrs. G. E. Perrin).

Range: Western Australia only.

25. P. CYCNOCEPHALA Fitzg.—A small plant, probably often confused with *P. mutica*, from which it may be distinguished by a more robust habit, by the flowers being massed together, and by the "swan-headed" labellum-appendage from which its name is derived. The labellum is irritable, springing back towards the column when shaken or touched. I have observed this characteristic in all the remaining species included below except *P. Daintreyana*.

Merri Merri Creek, Vic., Sept., 1897 (M.R.), Monarto South, S.A., Sept., 1906 (Dr. and Mrs. R. S. Rogers), Bellerive, Tas., Oct., 1920 (M.R.), Bulladelah, N.S.W., July, 1924 (A. Rupp).

Range: New South Wales, Victoria, South Australia and Tasmania, on grassland.

26. P. MUTICA R. Br.—Similar to *P. cycnocephala* and of similar habit, but more slender, reaching, I think, a greater height, and flowers fewer. Whole plant, as in *P. cycnocephala*, pale green.

Warialda, N.S.W., Sept., 1905 (M.R.), Monarto South, S.A., Sept., 1913 (Dr. and Mrs. R. S. Rogers).

Range: All States except Western Australia.

27. P. SQUAMATA R. Br. (Text-fig. 7).—Maiden and Betche (*Census*) include *P. squamata* and *P. Mitchelli* as varieties of *P. rufa* R. Br. Dr. Rogers (*South Australian Orchids*) restores them to specific rank, and I prefer to follow him, because, though *P. rufa* seems to be a very variable species and to approach both these forms, the latter typically show scarcely any variation over a very wide range of habitat. I have *P. squamata* from Launceston, Tas., and from Bulladelah, N.S.W.—900 miles distant—and they are alike in all respects. So also I have *P. Mitchelli* from Grangeville, S.A., and from Warialda, in the extreme north of New South Wales, and if the specimens got mixed I could not distinguish them. I think that any confusion between *P. squamata*, *P. rufa*, and *P. Mitchelli* is due to the variability of *P. rufa*. *P. squamata* is named from the unusual number of appressed stem-bracts. Flowers several, small, sepal-points acuminate, galea prominently down-curved and then suddenly straightening at the tip. Flowers rather prominently marked with red. Basal rosette withered at flowering time.

Westbury Road, Launceston, Nov., 1921 (M.R.); Markwell, near Bulladelah, N.S.W., Sept., 1924 (Dr. H. L. Kesteven). I had found a budding plant at Bulladelah early in Sept., 1924, which I considered to be either *P. rufa* or *P. squamata*. Dr. Kesteven sent me the specimens now in my herbarium.

Range: New South Wales, South Australia, and Tasmania; probably Victoria also.

28. P. RUFA R. Br. (Text-fig. 8).—See remarks under *P. squamata*. Dr. Rogers has sent me two beautiful South Australian specimens which have no red about them at all. The only other specimen I have, and all specimens I have seen in New South Wales, are rather heavily marked with red like *P. squamata*, but the

flowers are twice the size of that species, and the sepals have long fine points. In Dr. Rogers's flowers they have still longer points. Basal rosette withered at flowering time.

Blackwood, S.A., Nov., 1906 (Dr. and Mrs. R. S. Rogers), Barraba, N.S.W., Sept., 1913 (M.R.).

Range: All States.

7. *Pterostylis squamata* R. Br. Launceston, Tas. × ½.
8. *Pterostylis rufa* R. Br. Barraba, N.S.W. (complete specimen), Blackwood, S.A. (flower). × ½.
9. *Pterostylis Mitchelli* Lindl. Warialda, N.S.W. × ½.
10. *Pterostylis vittata* Lindl. National Park, S.A. × ½.

29. P. MITCHELLI Lindl. (Text-fig. 9).—Basal rosette not withered at flowering time. Otherwise considerably resembling Nos. 27 and 28, but always with green flowers. Dr. Rogers very carefully describes these three closely-allied species (*South Australian Orchids*, p. 42).

Grangeville, S.A., Aug., 1907 (Dr. and Mrs. R. S. Rogers), Gunyerwarildi, Warialda District, N.S.W., Sept., 1916 (M.R.).

Range: All States except Western Australia, according to Dr. Rogers. I should be surprised to find such a characteristically "interior" species in Tasmania.

30. P. DAINTREYANA F. v. Muell.—An interesting little plant, apparently restricted to the Port Jackson district or not extending far from it. In mossy places on sandstone outcrops. Plant up to 1 foot high, very slender; basal rosette

present at flowering time. Stem-leaves bract-like below, expanding towards the very small green flowers, which have long points to the sepals.

Gordon, N.S.W., June, 1917 (M.R.).

31. P. VITTATA Lindl. (Text-fig. 10).—Chiefly in tea-tree scrub on the edge of sea beaches. Stem from a few inches to well over a foot. No basal rosette observed. Stem-leaves very strongly developed, lanceolate, the largest about the middle. Flowers several, ½ inch to about 1 inch long from the roof of the galea to the down-turned tips of the lateral sepals; sometimes greenish, but more usually heavily marked with reddish or purplish-brown. An attractive species.

Sandringham, Vic., July, 1892 (M.R.), National Park, S.A., May, 1909 (Dr. and Mrs. R. S. Rogers), Cannington, W.A., Sept., 1922 (Mrs. G. E. Perrin), Cape Barren I., Bass Straits, July, 1923 (Archdeacon Atkinson).

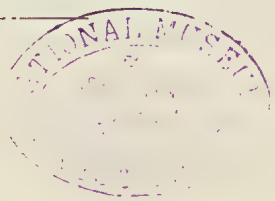
Range: All States except New South Wales and Queensland.

32. P. LONGIFOLIA R. Br.—Somewhat resembling No. 31, but more slender, leaves longer and narrower, and flowers always quite green. Basal rosette withering before flowering time, or, if present, on a separate stem. Plant occasionally very tall.

National Park and Kangaroo Island, S.A., July, 1909 (Dr. and Mrs. R. S. Rogers), Lane Cove, N.S.W., July, 1919 (M.R.), Hobart, Tas., Aug., 1920 (M.R.), Grampians, Vic., Oct., 1922 (Mrs. G. E. Perrin), Bulladelah, N.S.W., July, 1923 (M.R.).

Range: All States except Western Australia.

(The accompanying pen-and-ink sketches are all from herbarium specimens, though an effort has been made to avoid the straightening effect of pressing upon the curve of the galea.)



NOTES ON AUSTRALIAN DIPTERA. No. vii.

By J. R. Malloch.
(*Communicated by Dr. E. W. Ferguson.*)

(Twenty-three Text-figures.)

[Read 30th September, 1925.]

In this paper I present notes on some previously described species and descriptions of some others that appear to be new to science. With the exception of one species which belongs to the British Museum, all the types will be sent to Dr. E. W. Ferguson, from whom most of them were received for identification.

Family Sepsidae.

The members of this family have a characteristic ant-like appearance that readily distinguishes them from most of their allies. Hendel's most recent papers dealing with the acalyptrate Diptera give prominence to the presence or absence, divergence or convergence, of the postvertical pair of bristles as characters for the separation of the families. While one must admit that these bristles are quite important as criteria in grouping the insects, a careful scrutiny of the families discloses the fact that, just as is the case with other characters, there are some departures from the general rule here. Hendel ascribes to Sepsidae divergent postvertical bristles, but in one of his papers he parenthetically refers *Eurychoromyia* Hendel to the family, despite the fact that it lacks these bristles. I rather incline to doubt the propriety of assigning this genus here, but have not seen it, so cannot give a definite opinion on the point. However, there is one undoubted sepsid amongst the Australian material before me, which lacks the postverticals, and for which I herein propose a new genus. The preapical tibial bristle is stated to be absent by Hendel, but I am confident that in some species it is present, though small and weak, as I can detect a setula or short bristle in practically the normal position in these.

Strictly speaking the family is distinguished from its nearest allies by the distinct auxiliary vein, which is complete and well separated from the first vein; the presence of vibrissae; bare, or almost bare, arista; absence of presutural dorsocentral bristles; presence of one or more long setulose hairs on lower margin of metathoracic spiracle; incomplete sixth wing vein; lack of pteropleural and sternopleural bristles; and the vestigial palpi. The postvertical bristles are absent or present; when present they are divergent; orbit with, at most, one distinct bristle.

In 1906 de Meijere published a revision of the Indo-Australian species of *Sepsis* in which he recorded two species from Australia (*Ann. Mus. Nat. Hungar.*, vol. 4, p. 165). I have both of these species before me, as well as one he described from Singapore, but did not record from Australia, and in addition have three related forms as yet undescribed, for two of the latter having to propose new genera in this paper.

All the known species of the family occur in the adult stage upon garbage, carrion, or vegetation, some being very abundant on flowers; the larvae feed in manure and carrion. The adults are very rarely found in houses, so do not come into contact with human food as a rule, and thus may be considered as innocuous.

Key to known Australian Genera.

1. Postvertical bristles lacking; each orbit with one strong bristle .... *Xenosepsis*, n. gen.
   Postvertical bristles present, divergent; no distinct orbital present 2
2. Basal cells of wings separated by a strong vein ..... *Sepsis* Fallén
   Basal cells of wings not separated (Fig. 1); mesopleura with a strong bristle on hind margin above ..... *Australosepsis*, n. gen.

Genus Sepsis Fallén.

This cosmopolitan genus is represented by four species in the material now before me. One of these, *hirsuta* de Meijere, has, like *violacea* Meigen, but one distinct pair of thoracic dorsocentral bristles, and has also a strong mesopleural bristle as in *Australosepsis*, characters which might be utilized to separate them subgenerically from the other species, but there is nothing to be gained by adopting this course unless in a consideration of the species from all over the world, so I leave the matter to some future worker to decide.

I give below a key for the identification of the available Australian species.

Key to Species.

1. Thorax with one pair of strong dorsocentral bristles; frons quite conspicuously haired; dorsum of thorax evenly haired, most noticeably so in male; fore femur of female with anteroventral and posteroventral series of short black spines on apical half, of male with similar series, which are confined more to median third and are not situated upon raised bases; wing without a black spot at apex of second vein; legs more noticeably hairy than in other species; mesopleura with a distinct bristle on hind margin above ..... *hirsuta* de Meijere
   Thorax with two pairs of strong dorsocentral bristles; frons bare except on orbits; disc of mesonotum with very inconspicuous hairs, which are practically all confined to acrostichal area and in line with dorsocentrals; fore femur in female without well developed spines, of male with distinct spines, some of which are on distinctly elevated bases; mesopleura without a distinct bristle 2
2. Wing normally with a black spot at apex of second vein; no acrostichal setulae present behind level of anterior pair of dorsocentrals; veins 3 and 4 of wings not at all, or only slightly, convergent apically 3
   Wing without a black spot at apex of second vein; acrostichal setulae continued sparsely well behind transverse line of anterior dorsocentrals; scutellum not opaque velvety-black, but black, coloured as disc of thorax; veins 3 and 4 quite distinctly convergent apically ..... *coprophila* de Meijere
3. Black species, the scutellum velvety opaque-black, with apex white dusted; fore femur in both sexes without prominent hairs on anteroventral surface basally, with 1-3 short black setulae ..... *plebeia* de Meijere
   Fulvous yellow species, scutellum yellow; fore femur of male with numerous black hairs on basal half of anteroventral surface ..... *hirtifemur*, n. sp.

Sepsis hirsuta de Meijere. Text-figures 2, 3.

This species is similar to *violacea* Meigen in having but one pair of dorsocentral bristles and in possessing a mesopleural bristle. It differs, however, in the spinose fore femur of the female, in which respect it is like *Nemopoda* species. The preponderating colour in most specimens is fulvous yellow, with the dorsum of thorax and of abdomen more frequently dark; some specimens are almost entirely black. The fore femur of male is as in Figure 2, that of female as in Figure 3. I have not seen a specimen with a dark subapical spot on wing.

Length, 4-6 mm.

Originally described from Parramatta and Botany Bay, N.S.W. I have before me many specimens of both sexes from Sydney and Como, N.S.W.

SEPSIS COPROPHILA de Meijere.

I have before me one female which I identify as this species. The characters cited in the key, coupled with de Meijere's description in the paper already referred to, should enable anyone to identify the species.

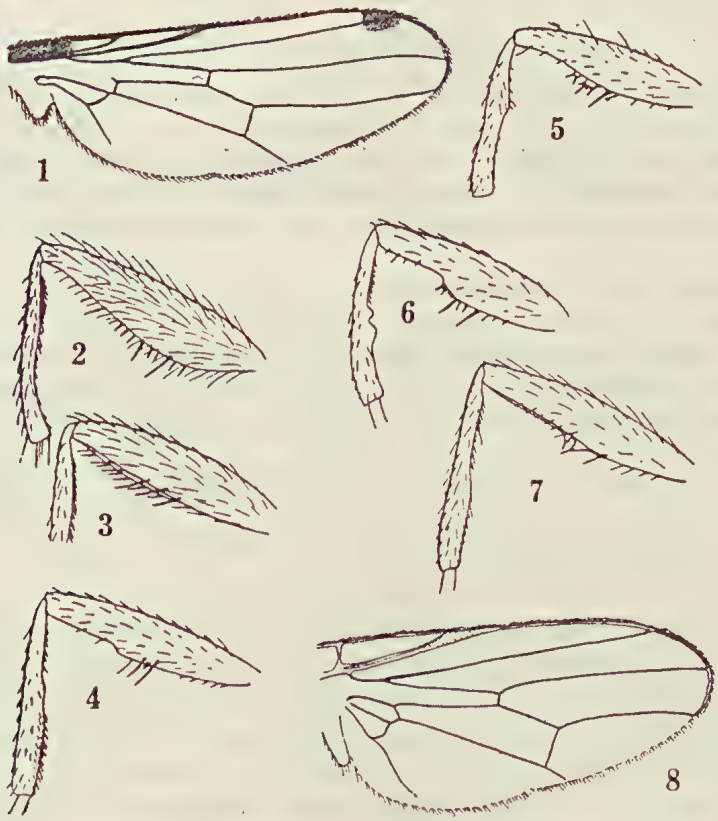
Originally described from Singapore. I have it from Eidsvold, Queensland.

SEPSIS PLEBEIA de Meijere. Text-figure 4.

A small black species closely resembling the European *cynipsea* Linné. The fore femur lacks the rather dense hairs on the basal half of anteroventral surface so evident in *hirtifemur*, and the armature as seen from behind is as shown in Figure 4. The female has no fore femoral spines.

Length, 3-4 mm.

Originally described from Sydney. I have it from Sydney, Como, Cronulla, and Botany Bay, N.S.W.



Text-figure 1.—*Australosepsis fulvescens*, n. gen. et sp. Wing of male.
Text-figure 2.—*Sepsis hirsuta* de Meijere. Fore femur of male.
Text-figure 3.—*Sepsis hirsuta* de Meijere. Fore femur of female.
Text-figure 4.—*Sepsis plebeia* de Meijere.
Text-figure 5.—*Sepsis hirtifemur*, n. sp. Fore femur and tibia of male.
Text-figure 6.—*Australosepsis fulvescens*, n. gen. et sp. Fore femur and tibia of male.
Text-figure 7.—*Xenosepsis sydneyensis*, n. sp. Fore femur of male.
Text-figure 8.—*Piophila* ————. Wing.

SEPSIS HIRTIFEMUR, n. sp. Text-figure 5.

Male.—Fulvous yellow, shining; dorsum of thorax with a central dark suffusion; abdomen polished, blackened above and with a purplish tinge. Wing with a blackish spot at apex of second vein, the costal vein white beyond the black spot. Sternopleura white dusted above.

Vertical, postvertical, and ocellar bristles strong; a few microscopic hairs on orbits; a long setula on second antennal segment; vibrissae duplicated; cheek very narrow; eye facets enlarged in front. Thorax with two pairs of widely separated dorsocentrals, a series of hairs in line with these, and paired acrostichal hairs, anteriorly; basal scutellars minute. Abdomen with distinct tergal bristles. Fore femur and tibia seen from behind as in Figure 5, the anteroventral surface of femur with numerous black hairs on basal half; mid and hind femora each with an anterior bristle; mid tibia with one anteroventral and two posterior bristles; hind tibia attenuated basally, with one anteroventral, one anterodorsal, and one posterodorsal bristle; mid metatarsus with some short black bristles. Inner crossvein of wing at less than one-third from apex of discal cell; first posterior cell not narrowed at apex.

Length, 3 mm.

Type, Mosman, N.S.W.

Genus AUSTRALOSEPSIS novum. Text-figure 1.

Generic characters.—Venation of wing as in *Pandora* Haliday, the vein separating first and second basal cells lacking (Fig. 1). Differs from that genus, the only other of the family with this venation, in having the vibrissal angle but slightly produced, the frontal orbits without strong median bristle, fore femora as in *Sepsis*, not simple, in male, and the scutellum short and convex on disc.

An offshoot from *Sepsis* apparently.

Genotype, *Australosepsis fulvescens*, n. sp.

There appears to be but one species in the material available, but there is a remarkable difference between the paler and darker specimens, so that it appears justifiable to give to the dark specimens a varietal name, as indicated here.

A. Thorax, abdomen and legs entirely or almost entirely fulvous yellow ..... *fulvescens*, n. sp.

AA. Thorax and abdomen entirely black, the former shining, the latter glossy and with a purplish tinge; legs largely black. ..... var. *atratula* n.

AUSTRALOSEPSIS FULVESCENS, n. sp. Text-figures 1, 6.

Male.—Shining fulvous yellow, sometimes a little darkened on dorsum of thorax and abdomen. A black spot at apex of second wing vein, and a brown suffusion along costa to a little beyond humeral crossvein, costal vein from a little beyond apex of second vein to apex of fourth white.

Postvertical bristles moderately strong, divergent, all four verticals and one pair of ocellars present; a very short setula at middle of each orbit; frons bare; eye longer than high; cheek not as high as width of third antennal segment; vibrissae duplicated, the angle very slightly produced. Thorax with one humeral, one mesopleural, two notopleural, two pairs of dorsocentral, and two long and two very minute scutellar bristles. Abdomen constricted at apex of second tergite as in *Sepsis*, the tergites with distinct apical bristles. Fore femur and tibia of male as in Figure 6; fore tarsus of same sex normal, mid femur with

3 or 4 anterior bristles, mid tibia with one anteroventral and 3 or 4 posterior bristles, mid tarsi with a number of black bristles on basal two segments; hind femur usually with an anterior bristle beyond middle; hind tibia slender on basal half, thickened beyond, and with three bristles at middle, one anteroventral, one anterodorsal and one posterodorsal. Wing as in Figure 1, the crossveins sometimes a little more approximated.

Length, 3-4 mm.

Type and three paratypes, Sydney, N.S.W., 17.2.24; allotype. One paratype, Cronulla, N.S.W.

AUSTRALOSEPSIS FULVESCENS var. ATRATULA, n. var.

Male and female.—Differ from the type form in having the thorax and abdomen black; the femora and tibiae of mid and hind legs are largely black and apices of tarsi fuscous.

Structurally as in typical form.

Length, 3-4 mm.

Type, male, allotype, 2 male and 3 female paratypes, Sydney, 17.2.24; one male, Cronulla, N.S.W., Dec., 1924 (H. Petersen).

Genus XENOSEPSIS novum.

Generic characters.—Differs from all Sepsidae known to me in lacking the postvertical bristles. Each frontal orbit with one prominent bristle which is directed outward over eye; face carinate; one outstanding vibrissa present; head otherwise as in *Sepsis*. Thorax as in *Sepsis;* mesopleura with one bristle; dorsocentrals one pair. Legs as in *Sepsis*, but the preapical tibial bristle is quite evident, and there is a short longitudinal slit on dorsal surface of hind tibia near base in male. This last character may be sexual and not of generic import. Venation of wings as in *Sepsis*.

Genotype, *Xenosepsis sydneyensis*, n. sp.

XENOSEPSIS SYDNEYENSIS, n. sp. Text-figure 7.

Male.—Shining black, dorsum of thorax shagreened, that of abdomen polished and slightly purplish. Antennae and centre of face yellowish. Legs black, coxae, trochanters, fore femora and tibiae, bases of other femora, and tarsi, except their apices, yellowish. Wings without dark preapical spot. Halteres yellow.

Cheek almost linear; frons bare. Thorax with a pair of short bristles on acrostichal lines about midway from suture to dorsocentrals; upper part of sternopleura white dusted; scutellum short, apical bristles long, basal pair microscopic. Abdomen not noticeably constricted at second tergite, bristles evident only on the apical tergites, two at apex quite prominent. Fore femur as in Figure 7; mid femur with some short anterior setulae; mid tibia with an anteroventral bristle beyond middle; basal segment of mid and hind tarsi setulose; hind femora and tibiae without median bristles. Inner crossvein at about one-third from apex of discal cell; veins 3 and 4 slightly convergent apically.

Length, 4 mm.

Type and two paratypes, Sydney, N.S.W., 8 and 14.1.23.

Family Piophilidae.

This family has much the same appearance as Sepsidae, but they are not so slender and ant-like. They differ in venation of the wing, as shown in Figure 8, the auxiliary vein being practically fused with first at its apex; the costa is almost

broken just in front of apex of this vein. Palpi large; vibrissae strong; no setulae on hypopleura; preapical tibial bristle undeveloped; postvertical bristles divergent.

I have before me two species referable to this family, both of which appear to be European in origin. I give below a diagnosis for their identity.

It appears probable that the chaetotactic characters cited below will serve some taxonomist as criteria for the division of this genus into at least subgenera.

A. Frons without orbital bristles; humeral and sternopleural bristles undeveloped; dorsum of thorax very sparsely haired, distinctly shagreened; fore tarsi not dilated ..... *casei* Linné.

AA. Frons with a pair of distinct orbital bristles; humeri and sternopleura each with two bristles; dorsum of thorax with numerous erect hairs, not shagreened; fore tarsi compressed and dilated ..... *latipes* Meigen.

Piophila casei Linné.

A greenish or bronzy black species. Anterior half of frons, the face, cheeks, and palpi yellow. Legs variable in colour, generally yellow, with most of fore femora, all of fore tibiae, and apices of hind femora and hind tibiae broadly, black, the fore tarsi sometimes all black, sometimes yellowish in middle.

The shagreened thorax with its comparative absence of hairs, transversely rugose scutellum, and undilated fore tarsi characterizes this species.

Length, 4-5 mm.

Localities.—Sydney, Blue Mts., Illawarra and Waterfall, N.S.W., and Eidsvold, Queensland.

This is the species known the world over in economic literature as the "Cheese Skipper", from the lively actions of the larvae, which feed in cheese and preserved meats. Sometimes the flies occur in great numbers in provision houses.

Piophila latipes Meigen.

I identify as this species a female which agrees with Meigen's description so well that there is no doubt in my mind that I am correct. It is very closely related to *nigriceps* Meigen. The latter, however, has no strong orbital bristles and is different in colour and structure. Legs yellow, fore pair black except the coxae, trochanters, bases of femora, and knees.

Length, 3.5 mm.

Locality.—Sydney, N.S.W., 14.4.25.

Family Sapromyzidae.

Genus Sapromyza Fallén.

I have already defined this genus and *Sapromyzosoma* in one of my papers on Australian Diptera. I now present descriptions of a few species of each genus, some of them previously undescribed.

One species herein included, *aberrans*, might be placed in a separate subgenus from the others because of the presence of a distinct bristle behind the supra-alar bristle. I have noted the presence of this bristle in many Oriental and South American species of this genus and *Minettia*, but I have not yet decided the true significance of the character and therefore leave this species in *Sapromyza* in the meantime. The bristle referred to must not be confused with the posterior intra-alar bristle, the presence of which distinguishes *Minettia* from *Sapromyza*, both bristles being present in certain species of the former genus which I have seen.

SAPROMYZA ABERRANS, n. sp.

Female and male.—Head opaque clay-yellow, frons with a transverse dark grey mark extending between inner vertical bristles, and an irregular brown mark on each orbit, the two meeting on middle of frons; a dark mark between each antenna and eye; centre of face fuscous; apex of third antennal segment darkened; palpi black. Thorax clay-coloured, dorsum with four broad brownish vittae, the laterals irregular, subdivided by a grey vitta behind suture, the intervening areas, and especially the median one, greyish pruinescent; pleura with a broad blackish vitta over upper half, divided into two anteriorly, one branch above, the other below the spiracle, and a narrower vitta on upper part of sternopleura; scutellum fuscous, sides appearing darker than disc; postnotum clay-yellow. Abdomen concolorous with thorax, bases of tergites dark brown. Legs clay-yellow, fore and mid femora almost entirely, hind femora and all tibiae at apices, blackened. Wings brownish hyaline. Halteres whitish.

All frontal bristles strong and long; arista rather long haired; thorax with three pairs of strong postsutural dorsocentral and one pair of prescutellar acrostichal bristles; scutellum flattened, bristles subequal. Genitalia of female not spined. Fore femur without anteroventral comb; hind femur without preapical anteroventral bristle; preapical tibial bristle present. Inner crossvein at or slightly before middle of discal cell; penultimate section of fourth vein fully three-fourths as long as ultimate section.

Length, 5-6 mm.

Type, female, and allotype, Eungella Ra., 45 miles west of Mackay, Queensland, 1400-2400 feet, 25.9.23 (Goldfinch).

The specimen listed as allotype is in poor condition and teneral, but evidently belongs to this species.

SAPROMYZA PUNCTISETA, n. sp.

Male.—Head testaceous; orbits, frontal triangle, and the lines on which the frontal orbital bristles are situated yellowish-white dusted; ocellar spot fuscous; antennae and palpi orange-yellow; arista fuscous, face slightly darker in centre than on sides. Thorax darker than head, and densely lead-grey pruinescent, apex of scutellum and sutures of pleura paler, a small dark brown dot at base of each hair and bristle on dorsum. Abdomen brown, becoming greyish apically, apices of tergites yellowish. Legs testaceous yellow, fore femora, fore tibiae, apices of mid and hind tibiae, and of all tarsi brown or fuscous, the hind femora at apices and mid and hind tibiae near bases sometimes brownish. Wings hyaline. Halteres yellow.

Head as in *victoriae*. Thorax with three pairs of postsutural dorsocentrals and four series of intradorsocentral setulae, the median pairs quite strong from behind suture to scutellum; scutellar bristles equal. Legs and wings as in *victoriae*.

Length, 4 mm.

Type and two paratypes mounted on same card, Victoria (C. French). Brit. Mus.

SAPROMYZA VICTORIAE, n. sp.

Male.—Yellow testaceous, abdomen slightly shining. Head with whitish pruinescence on the narrow frontal orbits and on the lines of orbital bristles, the two stripes separated by a line of the reddish-yellow frontal colour, the frontal triangle forming a narrow whitish streak to anterior margin; face paler than

frons, whitish pruinescent on sides, and with a faint dark vertical central line; antennae reddish-yellow; arista fuscous; palpi yellow. Thoracic dorsum with four broad brownish vittae, the outer one on each side between submedian one and lateral margin, the median pair continued over scutellum; pleura not vittate. Apices of abdominal tergites a little paler than bases. Legs yellowish testaceous, fore femora, apices of all tibiae and a ring near middle of at least mid and hind tibiae brownish. Wings hyaline. Halteres yellow.

Anterior fronto-orbital bristles rather far removed from eye; ocellars small; arista subnude; eye higher than long, narrowed below; cheek not as high as width of third antennal segment; palpi slender. Thorax with three pairs of postsutural dorsocentral, and one pair of prescutellar acrostichal, bristles, six series of intradorsocentral setulae present anteriorly. Fore femur without anteroventral comb; preapical tibial bristle present on all legs, long on fore pair; hind femur without preapical anteroventral bristle. Inner crossvein at middle of discal cell; last section of fourth vein nearly twice as long as preceding section; outer crossvein at about its own length from apex of fifth vein.

Length, 4 mm.

Type, Melbourne, Victoria (G. F. Hill).

Sapromyza spinigera, n. sp.

Female.—Reddish testaceous, slightly shining, the surface obscured by yellowish-grey dusting, thoracic dorsum with two faint, slender, brownish, submedian vittae; abdomen more greyish than thorax; orbits and frontal triangle greyish, much paler than other parts of frons; palpi blackened apically. Wings yellowish-hyaline.

All frontal bristles long and strong, surface hairs numerous but short on sides and anteriorly; arista plumose; face with a convexity in centre above mouth; cheek about as high as width of third antennal segment. Thorax with four pairs of strong dorsocentral, and four pairs of quite conspicuous acrostichal, bristles, the anterior pair of both series in front of suture; a short bristle mesad of the presutural intra-alar bristle; an irregular series on short hairs between the acrostichals and dorsocentrals; scutellum flattened above, bare on disc, bristles subequal; both sternopleurals strong. Abdomen stout, third visible tergite with the bristles on lateral portions of hind margin denser and longer than usual; fourth tergite with quite dense long black setulose hairs or bristles on entire length of exposed portion at the lateral curves which are directed upward and outward; genital segment not spinose. Fore femur with an anteroventral comb; hind femur without an anteroventral preapical bristle; preapical tibial bristle present. Inner crossvein at middle of discal cell; sixth vein almost complete, faint apically.

Length, 5 mm.

Type, Ararat, Victoria (G. F. Hill).

An aberrant species, possessing as it does a bristle mesad of the presutural intra-alar, and a very long sixth vein.

Sapromyza hirtiventris, n. sp.

Male and female.—Similar to preceding species in colour, differing in having the stripe between the faint submedian vittae grey or fuscous, the palpi yellow, frontal orbits and triangle less definitely greyish, and the abdomen more greyish fuscous. Tarsi dark at apices.

Arista sparsely pubescent; frons without fine surface hairs; face not convex. Thorax with the same dorsocentrals as in last species, but the acrostichals, except

the prescutellar pair, very short, the intradorsocentral area with four series of hairs, short in front; extra bristle mesad of the presutural intra-alar present. Female with a large section in middle of second and third visible tergites furnished with rather dense, fine, moderately long, erect, black hairs, the other hairing and bristling normal. Internal processes of male genitalia (3) long, heavily chitinized, glossy black. Legs and wings as in *spinigera*.

Length, 7-8 mm.

Type, female, and allotype, Ararat, Victoria (G. F. Hill). Paratypes, four, Bamawm, Victoria (G. F. Hill).

Sapromyza fuscocostata, n. sp.

Female.—Shining fulvous yellow. Third antennal segment, arista, and a small ocellar spot, fuscous. Thoracic dorsum with two fuscous vittae along the lines of dorsocentrals. Abdomen with a series of dark central spots apically, one to each tergite. Legs fulvous yellow, fore femora, all tibiae, entire fore tarsi, and apices of mid and hind tarsi, black. Wings yellowish, costa from base to apex of fourth vein, and outer crossvein, narrowly fuscous brown. Halteres yellow.

Frontal orbits shining, well separated from eyes anteriorly, the anterior bristle smaller than the posterior one; postvertical bristles long; ocellars minute; face convex; parafacials white pruinose; antennae normal; arista pubescent; cheek about one-fourth as high as eye. Thorax with two pairs of strong and one pair of weak anterior postsutural dorsocentrals, one pair of strong prescutellar acrostichals, and six or eight series of intradorsocentral setulae; scutellum convex, the bristles equal; propleural bristle strong. Abdomen normal. Fore tibia with very poorly developed anteroventral preapical comb; fore tarsi not noticeably thickened; preapical tibial bristle present. Inner crossvein at middle of discal cell; ultimate section of fourth vein about equal to penultimate one.

Length, 6-7 mm.

Type and one paratype, Mittagong, N.S.W.

Sapromyza sciomyzina Schiner.

This species was recorded from New Zealand by Schiner in his original description. This is an error similar to that which he made in his locality for *Poecilohetaerus schineri* Hendel (= *decora* Schiner), both of which were really from Australia. I unfortunately did not take *sciomyzina* into consideration when I described *atriventris* mihi in a recent paper on Australian Diptera, as no species that I have seen from the two regions are identical, and thus created a synonym, as the two names apply to the same species.

Genus Sapromyzosoma Malloch.

This generic name had been used by Lioy many years ago, but I made use of it intentionally a year or two ago because it may possibly be the same as Lioy's and I am in doubt as to whether van der Wulp's name *Homoneura* is applicable to the same group. If my concept and Lioy's are identical the name *Sapromyzosoma* will remain, and if they are different, and my concept is the same as *Homoneura*, then the latter will replace *Sapromyzosoma*, a rather cumbersome name at best.

I believe that I have correctly identified one of Kertesz's species, described from New Guinea, amongst those sent to me and redescribe it briefly herein, using characters in large part not mentioned in the original description. Black species

are very rare in this genus and the one now listed, *signatifrons*, has very much the appearance of a *Minettia*, mimicking, rather closely, *longipennis* Fallén, the genotype of that genus, except that the wings are not blackened at bases.

SAPROMYZOSOMA PROXIMELLA, n. sp.

Male.—Testaceous yellow, subopaque. Apical halves of palpi, ocellar spot, arista, and a mark on middle of occiput at neck, black; orbits not shining; antennae yellow. Thorax greyish pruinescent, with a pair of faint brownish vittae along the lines of dorsocentral bristles, and a brownish mark alongside the upper margin of each humeral callosity. Abdomen unmarked. Legs clay-yellow. Wings hyaline, marked as in *horvathi* Kertesz, both the crossveins and apices of second, third, and fourth veins with brown clouds, the one on outer crossvein most distinct on upper extremity, spotlike, those on apices of second and fourth veins distinctly proximad of the tips, that on third at tip. Halteres yellow.

Frons fully one-third of the head width; orbits not differentiated, the bristles long; ocellar pair long, parallel; arista plumose, longest hairs nearly as long as width of third antennal segment. Thorax with three pairs of strong postsutural dorsocentral bristles, and one pair of prescutellar acrostichals; intradorsocentral setulae in about six series; scutellum flat, bristles equal, apical pair cruciate. Fore femur with an anteroventral preapical comb. Inner crossvein of wing a little beyond middle of discal cell; last section of fourth vein very little longer than preceding section; outer crossvein at about half its own length from apex of fifth vein.

Length, 3 mm.

Type, Townsville, N. Queensland (G. F. Hill).

This species is very similar to *horvathi* Kertesz and *brevicornis* Kertesz, the wings being almost identical in venation and markings in all three (as Fig. 9). *S. horvathi* has the frons with a central blackish line, the third antennal segment blackened at apex, thorax more obviously vittate, and the abdomen with blackish fasciae at hind margins of the tergites. I have many specimens of *brevicornis* from Formosa before me; they all have the arista much shorter haired, the longest hairs being no more than one-third as long as the width of third antennal segment, and the thorax is even less noticeably vittate than in *proximella*.

Kertesz described *horvathi* from New Guinea, *brevicornis* from Formosa.

SAPROMYZOSOMA PREAPICALIS, n. sp. Text-figure 9.

Male and female.—Similar to *proximella*, but the palpi are yellow, the thorax is less evidently dusted and without any traces of dark vittae, and the insect is larger. Wing as in Figure 9.

Length, 4-4.5 mm.

Type, male, allotype, and five paratypes, Waterfall, N.S.W., January, 1925 (H. Petersen).

SAPROMYZOSOMA ARMATA, n. sp.

Female.—Testaceous yellow, shining. Third antennal segment, arista, and apices of palpi, black; abdomen sometimes more or less fuscous in part, but this colour is evidently a discoloration. Wings hyaline, inner crossvein sometimes slightly darker than the other veins. Halteres yellow.

All frontal bristles strong, no evident surface hairs present; arista distinctly pubescent; face concave in profile. Thorax with three pairs of strong postsutural dorsocentral, and one pair of prescutellar acrostichal, bristles, the intradorso-

central setulae in about eight series; scutellum flat on disc, bristles equal. Abdomen stout, genital segment armed with about eight short stout bristles. Fore femur with preapical anteroventral comb; preapical tibial bristle present; inner crossvein distinctly beyond middle of discal cell; outer crossvein at not more than half its own length from apex of fifth vein; penultimate section of fourth vein about two-thirds as long as ultimate section.

Length, 5-7 mm.

Type, Ararat, Victoria (G. F. Hill). Paratypes, Seaford, Victoria (W. F. Hill); East Australia (Dr. T. P. Lucas; Brit. Mus.).

A male specimen which appears to belong to this species is from Eidsvold, Queensland. In this specimen the last section of fourth vein is barely longer than the preceding section.

This species agrees very well with the description of *fuscicornis* Macquart, but the antennae are given as black in that species and there is no mention of the colour of the palpi, which leads one to assume that they are yellow in *fuscicornis*.

Sapromyzosoma signatifrons (Kertesz).

Male.—Glossy black. Frons subopaque, brownish-black, the anterior margin narrowly testaceous yellow, antennae brownish-yellow, arista fuscous; face slightly shining, with white pruinescence; palpi brownish. Thorax not vittate, almost without pruinescence. Legs fuscous, tibiae and tarsi testaceous yellow. Wings hyaline. Knobs of halteres black.

All frontal bristles strong; antennae normal; arista plumose; face slightly convex in middle vertically; cheek about as high as width of third antennal segment. Thorax with three pairs of strong postsutural dorsocentral, and one pair of prescutellar acrostichal bristles; intradorsocentral setulae in 10-12 series; scutellum flattened on disc, not transverse at apex, bristles equal; anterior sternopleural short. Abdomen stout. Fore femur with preapical anteroventral comb; preapical tibial bristle present on all legs, weak on hind pair. Inner crossvein a little before middle of discal cell; outer at about half its own length from apex of fifth vein; penultimate section of fourth vein more than three-fourths as long as ultimate.

Length, 3-4.5 mm.

One male, Melville Is., N.T. (G. F. Hill).

Sapromyzosoma eidsvoldensis, n. sp.

Female.—Head yellowish testaceous, ocellar spot, palpi, and third antennal segment broadly, black; sides of interfrontalia darker than centre; arista dark. Thorax darker than head, largely dark greyish, and with grey pruinescence, centre of dorsum broadly grey, the edges of the grey stripe each with a dark line, a dark brown mark along the inner side of each humeral callosity, faint indications of sublateral vittae posteriorly, and dark brown dots at bases of all bristles and hairs, largest at bases of the bristles; humeri and scutellum yellow testaceous, the scutellum dark on sides, and with two faint discal marks. Abdomen testaceous yellow, with a central spot on each of the apical two or three tergites, and a fascia on the hind margin of each, black, the fasciae roundly widened on each side on dorsum and narrowly connected with the black lateral margin of each tergite below; sternites clay-yellow. Legs testaceous yellow, femora sometimes darkened basally, each femur with a black spot near apex below, opposed to a similar spot

on each tibia near base. Wings hyaline, crossveins very faintly clouded. Halteres yellow.

Frons one-third of the head width, surface with a few short hairs, all bristles long and strong; antennae normal; arista distinctly pubescent; cheek about as high as width of third antennal segment. Thorax with 1 + 3 dorsocentrals, one pair of strong prescutellar acrostichals, and six series of intradorsocentral setulae; both sternopleurals strong, rather closely placed; scutellum flattened, bristles equal. Abdomen normal. Fore femur with weak preapical anteroventral comb; all tibiae with preapical bristle. Inner crossvein almost at middle of discal cell; outer crossvein about half its own length from apex of fifth vein.

Length, 3.75 mm.

Type and two paratypes, Eidsvold, Queensland, 20.4.24 (Bancroft).

SAPROMYZOSOMA FUMIFRONS, n. sp.

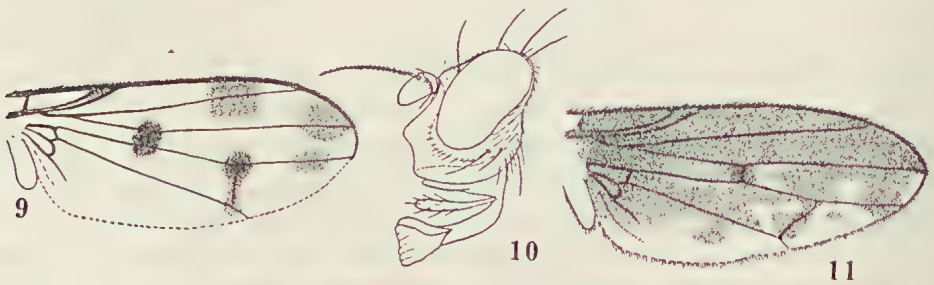
Male and female.—Tawny-yellow, shining. Frons infuscated except on anterior margin, face similarly coloured on sides, and above in centre; antennae fuscous, a little paler sometimes at base of third segment; arista black; palpi yellow. Thorax without markings. Abdomen with the hind margin of each tergite black, all except the first, and sometimes second, in male, entirely infuscated, general colour paler in female. Legs yellow. Wings hyaline, both crossveins and apex of second vein conspicuously clouded with fuscous, the mark on outer crossvein broadest on its upper extremity; the third vein with an almost indistinguishable cloud at apex. Halteres yellow.

All frontal bristles long and strong; orbits poorly differentiated; surface hairs microscopic; antennae normal; arista with its longest hairs not as long as width of third antennal segment; cheek not as high as width of that segment, the hairs fine and short. Thorax with three pairs of strong postsutural dorsocentrals, one strong pair of prescutellar acrostichals, and 6-8 series of intradorsocentral setulae; scutellum flattened, bristles equal; both sternopleurals distinct. Abdomen ovate, bristles weak. Fore femur with weak anteroventral comb; hind femur without distinct anteroventral bristles; tibiae all with preapical bristle. Inner crossvein beyond middle of discal cell; first posterior cell not narrowed at apex.

Length, 4-4.5 mm.

Type and two paratypes, Como, N.S.W., Dec., 1923; allotype and many paratypes, Waterfall, N.S.W., Jan., 1924 (H. Petersen).

Distinguished from its allies by the dark frons, face, and antennae, and the tripunctate wing.



Text-figure 9.—*Sapromyzosoma preapicalis*, n. sp. Wing.
Text-figure 10.—*Australina geniseta*, n. sp. Profile of head.
Text-figure 11.—*Australina geniseta*, n. sp. Wing.

Genus AUSTRALINA novum. Text-figures 10, 11.

Generic characters.—Runs to *Prosopomyia* Loew in Hendel's key to the genera of this family in "*Genera Insectorum*". It differs from this, and in fact from any related genus in possessing two very conspicuous bristles on a slightly tumid area on lower part of occiput, in having a prominent elevation in centre of face, and the frons very narrow for this family, about three times as long as wide, slightly wider in front than at middle, and not more than one-fourth of the head width. The postvertical bristles are small but distinct, ocellars microscopic, verticals and orbitals long, the latter both curved backward; profile of head as in Figure 10; the arista distinctly pubescent. Thorax as in *Sapromyza*; the presutural dorsocentrals absent; prescutellar acrostichals present. Venation of wing as in Figure 11, the same as in *Sapromyzosoma*. Tibial preapical bristle present.

Genotype, the following species.

AUSTRALINA GENISETA, n. sp. Text-figures 10, 11.

Male and female.—Frons yellowish, densely white dusted except on two narrow submedian longitudinal vittae, ocellar spot fuscous; face, cheeks, and lower half of occiput, black, a grey pruinescent mark on each parafacial below base of antennae, and one in centre of face above the protuberance, tip of the latter shining; upper part of cheek behind, including the part upon which the strong genal bristles are situated, yellow; antennae and palpi dusky yellow. Thorax blackish-brown, pale on dorsum, where it is densely whitish-grey dusted and has four dark vittae, the submedian pair paler and narrower than the sublaterals and becoming subobsolete posteriorly; lateral margins of mesonotum dark brown; scutellum yellowish, brown on sides. Abdomen brownish testaceous. Legs black, tibiae and tarsi stramineous. Wings conspicuously marked with dark brown (Fig. 11). Halteres dull-yellow.

Frons with short sparse stiff hairs. Thorax with three pairs of postsutural dorsocentrals, and six series of intradorsocentral setulae; scutellum slightly flattened on disc, the four bristles equal; propleural, mesopleural, and both sternopleural bristles strong, the latter rather closely placed. Hypopygium of male large. Fore femur without an anteroventral comb; hind femur with two or three preapical anteroventral bristles.

Length, 4-4.5 mm.

Type, male, and allotype, Darwin, N.T., the male labelled "on Pandanus", the female has an empty puparium mounted with it, and bears a label as follows: "pupated 6.2.14, emerged 17.2.14, associated with coccids on Pandanus" (G. F. Hill).

As extremely little is known of the habits of the larvae of this family, despite the frequency of the occurrence of the adults, this record is of considerable interest.

The puparium is rufous-brown in colour, and opaque. The anterior extremity is as wide as the average of the whole, distinctly flattened dorsoventrally as in many Drosophilidae, the small subsessile anterior respiratory organs each have a large number of pale papillae irregularly arranged at their apices. The body surface appears to be devoid of protuberances, at least on dorsum and sides, and the apical three or four segments are much constricted, forming a stout tapered tail, the divisions between the apical slender segments quite pronounced. Posterior spiracles not elevated.

Genus Incurviseta novum.

Generic characters.—This genus has the anterior pair of fronto-orbital bristles incurved, much as in *Camptoprosopella* Hendel and *Poecilohetaerus* Hendel, but the general habitus and several characters of the chaetotaxy distinguish it from either of these genera. *Poecilohetaerus* has four equally strong dorsocentrals, the anterior pair in front of the suture, and the head is differently shaped. In the other genus there are but two pairs of postsutural dorsocentrals and the arista is plumose, the hairs on the upper side being much longer than those on the under side, while the anterior pair of incurved orbital bristles are very close to the posterior pair, which is not the case in *Incurviseta*. The wing in the latter is the same as in *Sapromyza*, and the arista is pubescent. Sternopleurals two in number.

Genotype, *Sapromyza maculifrons* Macquart.

Incurviseta maculifrons (Macquart).

I have already recorded this species from Australia. The specimen upon which I based my identification was in rather poor condition, the frontal bristles being partially destroyed, and the wings lacking their tips. I provisionally placed it in the genus *Sapromyzosoma*, but I have seen other species with the same characters as the genotype and have decided that it is entitled to distinct generic status.

Family Ephydridae.

I defer publishing a generic synopsis of the Australian Ephydridae until I have seen a better representation of the species. Meantime I present descriptions of some of the genera and species that have been in my possession for some time.

Subfamily Notiphilinae.

This subfamily as treated by most authors contains a large number of genera which are rather unsatisfactorily distinguished from the other groups by the presence of a bristle at apex of second antennal segment. I consider that the presence of strong bristles on the dorsal surface of mid tibia is a more reliable character for distinguishing the group, and if this is accepted the number of known genera will be reduced to less than half a dozen, two of which are represented in material now before me, viz. *Paralimna* and *Notiphila*. I present data on the former below.

Genus Paralimna Loew.

Mid tibia with three or four long strong bristles on dorsal surface extending from near base to near apex; thorax in the Australian species with 1 + 3 dorsocentral bristles, and a pair of long prescutellar acrostichals which are nearly in line with the anterior pairs of dorsocentrals and appear to belong to that series; mesopleural bristles 1 to 3; sternopleural 1; frons with a pair of long strong bristles proximad of, or in transverse line with, anterior ocellus; arista plumose; face with bristles on sides which are rather far removed from eyes, central elevation quite prominent just below antennal insertions, the antennal foveae quite pronounced.

I present a diagnostic key for the identification of the three species now known to me, none of which I have identified as already described.

Key to Species.

1. Each frontal orbit with one strong backwardly curved bristle at middle, no short bristles between it and eye; the pair of long frontal bristles a little behind anterior ocellus transversely; ocellar and postvertical bristles indistinguishable; each humerus with but one bristle; abdomen without a dark dorsocentral vitta ..... *uniseta*, n. sp.

   Each frontal orbit with a long backwardly curved bristle about middle and between it and eye a pair of much shorter bristles which are forwardly directed; the pair of long frontal bristles distinctly proximad of anterior ocellus; ocellar bristles minute; abdomen with a distinct dorsocentral dark vitta connecting up the dark fasciae 2

2. Thoracic dorsum with a pair of subcontiguous dark central vittae, the large bristles set in dark dots, the fine hairs without dark dots at bases; each humerus with a setula above the strong bristle which is directed mesially; fore tarsi black ..... *atrimana*, n. sp.

   Thoracic dorsum without dark dorsocentral vittae, but with very distinct dark dots at bases of all hairs and bristles; each humerus with but one bristle; fore tarsus with most of basal segment yellow ..... *millepuncta*, n. sp.

PARALIMNA UNISETA, n. sp.

Male.—Head black, densely yelllowish-brown dusted; interfrontalia lavender-grey pruinescent, the triangle concolorous with rest of head; antennae and palpi black. Thorax densely tawny-brown pruinescent, paler on sides of mesonotum behind suture. Abdominal tergites greyish pruinescent, bases and apices narrowly brown, the apices very narrowly so. Legs black, femora slightly grey pruinescent. Wings hyaline, veins fuscous. Halteres whitish, stems yellow.

A pair of long parallel forwardly projecting bristles almost in line with the posterior margin of anterior ocellus; but one strong bristle on each orbit proximad of middle, some microscopic hairs in front of bristle and on the anterior margin of interfrontalia; frons wider than long and nearly half the head width; face rather abruptly protuberant below bases of antennae, almost vertical from that point to lower margin; about three bristles and some hairs on each parafacial; arista with about 10 rays above; eye higher than long; cheek not more than one-third of the eye height, genal bristle distinct. Thoracic chaetotaxy normal; intra-dorsocentral hairs very short and fine, in about 10 series; scutellum flattened on disc. Posteroventral bristles on fore femur mostly as long as femoral diameter; anterodorsal setulae on hind tibia distinct. Base of section of costa proximad of apex of first vein with about three outstanding bristles, and one at apex; last section of fourth vein about four-fifths as long as preceding section.

Length, 3 mm.

Type, Fish River, N.S.W., 25.3.1923.

PARALIMNA MILLEPUNCTA, n. sp.

Female.—Black, opaque, densely pale-grey pruinescent. Frons largely dark brown, not spotted, but irregularly suffused; face slightly suffused with paler brown; antennae and palpi black. Thoracic dorsum with dark brown dots at bases of the hairs and bristles, the dots more or less aggregated, those at bases of the strong bristles on mesonotum and scutellum larger and darker; mesopleura with an irregular brown suffusion in middle. Abdomen with a chocolate-brown dorsocentral vitta which is connected with the anterior and posterior fasciae on each tergite, the anterior fasciae narrow in centre and broader on sides; a blackish spot over each spiracle. Legs black, grey dusted; basal segment of fore tarsi and basal two segments of mid and hind pairs yellow. Wings hyaline. Halteres yellowish.

Frons rather noticeably short haired, a pair of bristles almost in line with hind margin of posterior ocelli; interfrontal bristles well in front of anterior ocellus; the two bristles between orbitals and eye short and quite close together; face much as in *uniseta*, but with one moderately long, and one shorter, bristle on each side below tips of antennae, and below and laterad of these some fine hairs; cheek about one-third of the eye height, genal bristle stout; arista with 9-10 rays above. Thorax as in *uniseta*, but the fine hairs less regularly arranged and much more sparse, especially on pleura and sides of mesonotum. Fore femoral bristles sparser and finer, and distinctly shorter than in *uniseta*; hind tibia with a few noticeable posterodorsal setulae. Costa lacking the three or four bristles beyond the basal break which are present in last species.

Length, 5-6 mm.

Type and 3 paratypes, Eidsvold, Queensland; 1 paratype, Narrandera, N.S.W.

PARALIMNA ATRIMANA, n. sp.

Male.—Differs from preceding species in being more lead-grey in colour of the pruinescence; in having the thoracic dorsum with faint dark dots at bases of the large bristles only, a distinct dark dorsocentral vitta; the abdominal markings narrower, no spot over the spiracles; and the fore tarsi entirely black.

The face has three larger bristles on each side, the orbital bristles are longer, there is a fine upcurved bristle above the humeral bristle, and there are one or two costal bristles beyond the basal break as in *uniseta*.

Length, 3-4 mm.

Type and one paratype, Belaringar, N.S.W., 1.6.23; one paratype, Collaroy, Sydney, N.S.W., 29.1.24; three paratypes, Narrandera, N.S.W.; one paratype, Eidsvold, Queensland.

Genus NOTIPHILA Fallén.

This genus is distinguished from *Paralimna* by the shorter costal vein, which ends at, or just beyond, apex of third vein; and the presence of 1 + 2 dorsocentral bristles on thorax. I present below the description of one species.

NOTIPHILA FUSCIMANA, n. sp.

Male and female.—Head black, with brownish-yellow pollen, darker on interfrontalia and triangle in front of anterior ocellus; antennae yellow, third segment brownish above; arista fuscous; palpi yellow. Thorax black, brownish pollinose on dorsum, more greyish and with a slight olive tinge on pleura, mesonotum with a pair of faint, darker, median vittae anteriorly, narrowly separated by a pale line; the bases of the large bristles inserted in small black spots; mesopleura with a brown central mark. Abdomen greyish pruinescent, each tergite with four large, irregular, brownish, or fuscous, spots, the bristles and hairs inserted in dark dots. Legs tawny-yellow, coxae, femora except apices, and the fore tarsi fuscous, fore tibiae of male dark apically. Wings hyaline, veins dark. Halteres yellow.

One or two fine hairs in front of the anterior orbital bristle; face with 2 or 3 bristles on lower half, and many fine hairs which extend above middle, of the sides; genal bristle strong. Hind tibia with one or two setulae on basal half of posterodorsal surface. Costa with one long and one short bristle at apex of first vein.

Length, 3-4 mm.

Type, female, Fish River, N.S.W., 25.3.23. Allotype and one paratype, Eidsvold, Queensland; three paratypes, Narrandera, N.S.W. A pair of paratypes from Murray Bridge, S.A., have the dorsum of thorax almost uniformly olive-brown, but do not differ in any other respect from the type material.

There is at least one other species of the genus in my hands yet.

Subfamily Ephydrinae.

Genus Hydrellia Rob.-Desv.

Hydrellia tritici Coquillett.

Black; distinctly shining. Frontal triangle and lunule connected, both glossy; orbits shining, a stripe between triangle and lunule, and the orbits opaque velvety-black; face and cheeks silvery-white pruinescent; antennae and palpi black. Thorax with a slight olive tinge on dorsum, a large velvety-black spot on each side in front of wing base; pleura white dusted. Abdomen with a greenish or bronzy tinge, very faintly dusted. Legs fulvous, variably marked with black, the fore tibiae almost or entirely, and fore tarsi entirely black, and mid and hind tarsi dark at apices, sometimes apices of fore femora, bases of mid tibiae and middle of hind tibiae blackish. Wings greyish hyaline. Halteres lemon-yellow.

Frons about half of the head width, broader than long, declivous from middle forward; ocellar bristles minute; postverticals long; upper orbital bristle directed over eye, twice as long as the lower forwardly directed one; face narrowest about midway from antennae to lower margin, with about three bristles on each side; genal bristle fine; cheeks narrow; arista rayed above, bare below. Thorax with two pairs of dorsocentrals, the anterior pair close to suture; mesopleura and sternopleura with one bristle each; scutellum flat above, with four marginal bristles and two short fine lateral marginal hairs. Abdomen slender. Legs slender, fore tarsi flattened a little apically. Inner crossvein about one-fourth to one-third from base of discal cell and a little before or beyond apex of first vein; penultimate section of fourth vein about five-sixths as long as ultimate section.

Length, 2-2.5 mm.

Originally described from Australia, this slender species appears to be very common in New South Wales, as I have many specimens from Botany Bay, Como, and Sydney. The type specimen is in the United States National Museum.

Genus Ilythea Haliday.

Generic characters.—Mid tibia without outstanding dorsal bristles; costa to apex of fourth vein; a pair of quite long divergent bristles situated within the ocellar triangle, none on interfrontalia proximad of anterior ocellus; each orbit with two bristles, the upper one sloping backward and outward, the lower one forward; second antennal segment with a short apical bristle; arista long rayed above; face convex, with distinct pruinescence, a short but pronounced protuberance above middle, and a number of long hairs or setulae on sides which stand clear of the narrow parafacials; mouth large; labrum not exposed; genal bristle small. Thoracic chaetotaxy as in *Paralimna*. Venation as in Figure 12, but the outer crossvein usually present.

Ilythea defecta, n. sp. Text-figure 12.

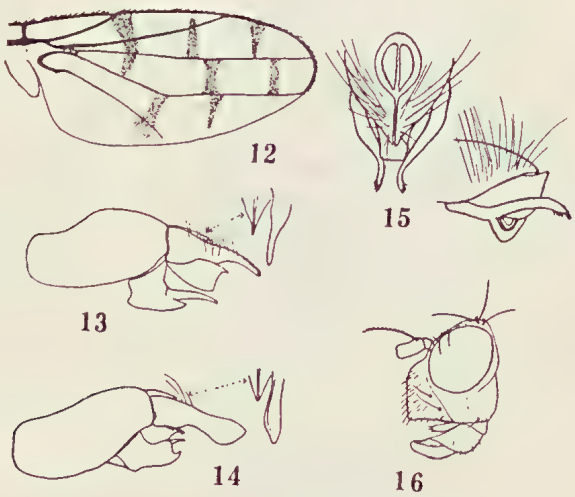
Female.—Shining black, with sparse brownish dusting, that on face more golden-brown and dense. Antennae below, mouth-parts, legs, and halteres dusky yellow. Wings with fuscous markings as in Figure 12.

Each side of face with three or four long setulose hairs, the upper one of each series curved upward, and between them and eyes some short hairs; frons about half the head width, much shorter than wide, concave in front. A few hairs between dorsocentral bristles; basal pair of scutellar bristles shorter than apical pair. Mid femur with two or three anterior bristles on apical half. Outer crossvein absent in type specimen.

Length, 1.75 mm.

Type, Eidsvold, Queensland, 2.4.24 (Bancroft).

This species is very similar to *Ilythea flavipes* Cresson described from Costa Rica, but in it the outer crossvein is present.



Text-figure 12.—*Ilythea defecta*, n. sp. Wing.
Text-figure 13.—*Ephydra breviseta*, n. sp. Male hypopygium.
Text-figure 14.—*Ephydra acrostichalis*, n. sp. Male hypopygium.
Text-figure 15.—*Scatella australiae*, n. sp. Male hypopygium.
Text-figure 16.—*Scatella alticeps*, n. sp. Head.

Genus EPHYDRA Fallén.

I have before me a number of specimens referable to this genus in the widest sense. They differ from the genotype and other European species in having the posthumeral bristle lacking, and the thoracic dorsocentrals, except the posterior two pairs, almost indistinguishable from the hairs. In the former character they are similar to the New Zealand forms which I have seen, but the latter have five pairs of dorsocentrals which are all strong. It may be necessary to erect a new subgenus for the Australian species, of which there appear to be two in my material.

The genus *Ephydra* may be distinguished from its allies by the protuberant bristly face; large mouth-opening; concealed labrum; almost bare arista; two pairs of long outwardly curved orbital bristles; lack of spines on mid tibiae and second antennal segment; costa extending to fourth vein; normal abdomen; almost straight, long, tarsal claws; and minute pulvilli. There are five pairs of dorsocentrals on thorax, and at least one mesopleural and one sternopleural present.

The two species now available may be distinguished as below.

Key to Species.

1. Males 2
   Females 3
2. Prescutellar acrostichals not developed ..... *breviseta*, n. sp.
   Prescutellar acrostichals well developed ..... *acrostichalis*, n. sp.
3. Prescutellar acrostichal region quite obviously tumid ..... *breviseta*, n. sp.
   Prescutellar acrostichal region not abnormal, regularly convex .... *acrostichalis*, n. sp.

Ephydra breviseta, n. sp. Text-figure 13.

Male and female.—Black, frontal triangle, disc of thorax, and most of dorsum of abdomen, shining, with a more or less metallic-greenish lustre, the abdomen sometimes with purple or violet reflections. Frontal and facial orbits and cheeks greyish, centre of face brownish dusted, interfrontalia opaque, blackish; antennae and palpi fuscous. Thorax with lateral margins of mesonotum and four faint discal vittae greyish; pleura greenish-grey dusted. Abdomen except dorsum, and most of legs largely greenish-grey dusted; knees, and mid and hind tarsi, brownish. Wings greyish hyaline. Halteres yellow.

Frontal triangle with all the hairs short. Thorax in male without prescutellar acrostichals, the surface normal, in female with well developed acrostichals which are situated upon an obvious rounded elevation; only the posterior dorsocentrals strong; scutellum short, rounded, convex, the basal bristles shorter than the apical pair. Male hypopygium as in Figure 13.

Length, 5-6 mm.

Type, male, allotype, four male and one female paratypes. Woy Woy, N.S.W., 2.9.23 (Mackerras); one male paratype, Mosman, N.S.W., 24.9.22.

Ephydra acrostichalis, n. sp. Text-figure 14.

Male and female.—Similar to the preceding species, but the dorsum of abdomen less shining, the frontal triangle comparatively narrower, and the male hypopygium as in Figure 14.

Length, 5-6 mm.

Type and allotype, on same mount, Middleton, S.A.

The abdomen of the type male of this species and those of two paratypes of the other were boiled in a 10% solution of caustic potash to facilitate delineation, and afterwards placed on the same mounts with the specimens.

Genus Scatella Rob.-Desv.

This genus has the head similar to that of *Ephydra*, the orbitals being directed outward over eyes, the face protuberant and setulose, second antennal segment without a spine, arista pubescent, mouth-opening large, labrum not exposed, and genal bristle present. The humeri have no bristles, the dorsocentrals are in two or three pairs, in the latter case the anterior pair are almost in transverse line with a pair of long strong acrostichals which are situated close to suture, this last feature characteristic of the genus. The tarsal claws are not very long, and are distinctly curved, while the pulvilli are well developed. Costa to apex of the fourth vein, wings usually with five or more hyaline spots between the veins, which are most readily seen when the wing is viewed from the base looking obliquely along the surface to apex.

None of the Australian species possess any outstanding structural peculiarities. The hypopygia of the males possess a peculiar feature in this genus, the claspers being connected about middle by a chitinous band which arches below as shown in Figure 15.

I present a key for the separation of the Australian species known to me.

Key to Species.

1. Only two strong pairs of dorsocentral bristles present, the one in line with the strong acrostichals close to suture very weak, represented by fine short hairs .. 2
   Three pairs of strong dorsocentrals present, the anterior pair almost in line with the strong acrostichals close to suture, and as long as or longer than these 4
2. Face silvery-white; cheek about half as high as eye, the genal bristle small and weak; second visible abdominal tergite in male not half as long as third, fourth about twice as long as latter; wings faintly spotted ..... *alticeps*, n. sp.
   Face yellowish-brown; cheek much less than half as high as eye, the genal bristle rather conspicuous; second visible abdominal tergite in male not noticeably shorter than third; wings quite distinctly spotted 3
3. All hyaline spots on wings very distinct, the one beyond outer crossvein in first posterior cell almost or entirely divided in middle, showing usually as a small spot against third and another against fourth vein, both these veins distinctly arcuated at that point; scutellum convex; setulae in front of anterior dorsocentrals very weak ..... *nitidithorax*, n. sp.
   All hyaline spots on wings faint, the one beyond crossvein in first posterior cell not touching veins, entire, the veins not at all or very faintly arcuated at this point; scutellum flattened on disc; setulae in front of anterior dorsocentrals strong, but much weaker than anterior acrostichals ..... *australiae*, n. sp.
4. Frontal triangle shining, with slight dusting; thoracic dorsum with distinct vittae on anterior half; legs black; wings quite conspicuously spotted .... *vittithorax*, n. sp.
   Frontal triangle not at all shining, densely yellowish-grey pruinescent like mesonotum, the latter without vittae; tarsi largely yellowish, darker at apices; wings faintly spotted ..... *immaculata*, n. sp.

Scatella alticeps, n. sp. Text-figure 16.

Male.—Frons fuscous, triangle almost glossy, ocellar spot and the narrow orbits opaque-brown; face and cheeks densely white dusted, almost silvery; antennae and palpi black. Thorax black, disc shining, darker on each side, lateral margins and pleura grey dusted; scutellum concolorous with mesonotum, apex slightly white dusted below. Abdomen black, with a slight greenish tinge, only slightly shining owing to the presence of quite dense brown-grey dusting. Legs black, tarsi brownish, femora grey dusted. Wings brownish-grey, the clear spots very faint. Halteres yellow.

Head as in Figure 16; a pair of divergent hairs behind posterior ocelli. Thorax with 3-4 fine hairs before anterior dorsocentrals, three pairs behind and two behind the acrostichals, the hindmost pair closer together than the preceding pair; scutellum slightly flattened on disc, basal hairs short. Fore femoral bristles short and fine; two or three long hairs at base of basal segment of fore tarsus below. Third vein slightly arcuate near middle of apical section.

Type, Collaroy, Sydney, N.S.W., 10.9.21.

Scatella nitidithorax, n. sp.

Male and female.—A much darker species than the preceding one, and very like *stagnalis* Fallén of Europe both in structure and wing markings. Face and cheeks yellowish-brown dusted, the thorax more distinctly shining on disc than in *alticeps* and with two rather evident grey dusted vittae anteriorly, the scutellum without grey dust at apex below, pleura brown dusted, abdomen much less dusted and more shining on dorsum, the legs black, and the spots on wings distinct.

The cheeks are not more than one-sixth of the eye height, with a stronger and longer genal bristle than in *alticeps*. Thorax with similar setulae, but there are no postsutural acrostichals in any specimen before me, and the scutellum is not flat, but is convex, on disc. The division of the pale spot in first posterior cell of

wing is coupled with a rather distinct arcuation of third and fourth veins at position of the spot. Fore tarsi of male without fine hairs at base below.

Length, 2-3 mm.

Type, male, allotype, and two paratypes, Sydney, N.S.W.

Two specimens which may belong here or to a closely related species have the spot in first posterior cell complete, and the veins very slightly arcuated.

Localities.—Tarro, Hunter River, and Belaringar, N.S.W.

SCATELLA AUSTRALIAE, n. sp. Text-figure 15.

Male.—A less shining and more brownish species than the last, distinguished as noted in the key. The triangle is very slightly shining; the thoracic dorsum is rather noticeably vittate, and less shining; the postsutural acrostichals are absent; and the third and fourth veins are quite regularly, though slightly, divergent on apical sections. Legs black, fore tarsi without fine basal hairs. Hypopygium of male as in Figure 15.

Length, 2 mm.

Type, Woy Woy, N.S.W., 22.9.23 (Mackerras).

SCATELLA VITTITHORAX, n. sp.

Female.—Somewhat similar to *nitidithorax* in colour and structure, but the frontal triangle is less shining, the thorax more distinctly marked with pale grey lines and dark brown vittae, and less shining. The wings are marked as in that species, but the hyaline spot in first posterior cell is complete, the one in the cell above it is larger, and the veins on either side of both spots are arcuate. Except in the possession of three pairs of strong dorsocentrals the species is similar to *nitidithorax*.

Length, 3-3.5 mm.

Type and three paratypes, Sydney, N.S.W.

SCATELLA IMMACULATA, n. sp.

Male and female.—Black, entirely covered with grey dusting, more yellowish-grey on mesopleura and parts of dorsum of thorax, even the frontal triangle without any gloss. Legs black, grey pruinescent, tarsi yellowish, darker at apices. Wings very faintly spotted.

The fore femur has rather longer posteroventral bristles than in the other species, there are no fine outstanding hairs at base of fore tarsus in male, there are sometimes one or two setulae behind the anterior acrostichals, and there is no arcuation of the third vein, nor of the fourth.

Length, 2-2.5 mm.

Type, female, allotype (greasy), and one female paratype, Belaringar, N.S.W., 9.9.23.

Genus LIMNELLIA novum.

Generic characters.—Similar to *Scatella* R.-D., differing in having no outstanding pair of acrostichals near suture, these hairs being almost uniform in length on entire extent of the series. The anterior orbital bristle is very much smaller than the posterior outwardly directed one, and is directed more forward than outward; the face is not so much produced and has about six bristles in an evenly spaced lower marginal series, and two or three on each side of the convexity, the central part having only a few short hairs. Otherwise as *Scatella*.

Genotype, the following species.

LIMNELLIA MACULIPENNIS, n. sp. Text-figure 17.

Female.—Head black; frons brown, with a grey pruinescent spot on each side of ocelli at vertex, and three on anterior margin; face white dusted, most noticeably so in antennal grooves and on sides; antennae and palpi fuscous. Thorax and abdomen black, the former opaque-brown dusted, densely so on dorsum which has a pair of submedian vittae and the sides grey pruinescent; pleura largely grey pruinescent; abdomen shining, conspicuously so apically. Legs black, tarsi yellowish. Wings fuscous, with numerous hyaline spots (Fig. 17).

Ocellar, vertical, and upper orbital bristles strong; postverticals absent; arista pubescent; cheek narrow; genal bristle weak. Thorax with two pairs of post-sutural dorsocentral bristles, the acrostichals in two complete series; basal scutellar bristles minute; disc of scutellum flattened. Legs normal.

Length, 1.75 mm.

Type, Sydney, N.S.W., 29.5.21.

Family Phoridae.

In the present paper I present a synopsis of the four species of the genus *Dohrniphora* Dahl known to me at present from Australia. Subsequently I hope to furnish a generic synopsis of the family and keys to the species of each genus I have seen from Australia.

The family is a very widely distributed one and contains some species with very remarkable life histories. The Ant Decapitating Fly of North America (*Apocephalus pergandei* Coquillett), the larvae of which affix themselves to the neck of a certain species of ant, feeding there until they decapitate their host, is among the most interesting biologically, but some of the apterous and semiapterous forms that occur in the nests of ants and termites are amongst the most peculiar in the order in so far as structure is concerned.

Genus DOHRNIPHORA Dahl.

This genus is distinguished by the venation of the wings, lack of a series of bristles on third vein, there being normally only one at base of the vein; presence of two strong bristles at base of mid tibia, and lack of long bristles on hind tibia, those that are sometimes present being very short. The genus belongs in the group which has the postantennal bristles reclinate and the tibiae of at least one pair of legs with strong bristles.

The species known to me are found in the larval stages in carrion, dead molluscs, decaying fungi, and in garbage.

Key to Species.

1. Hind tibiae with several short stout isolated black bristles on anterodorsal and anteroventral surfaces, without short laminate series of bristles on the flattened dorsal stripe; fore tibiae with one long bristle near middle on anterodorsal surface; scutellum with four bristles ..... *setitibia*, n. sp.
   Hind tibiae with at most one or two very short bristles on anterodorsal surface near base, the dorsal surface of same tibiae either not flattened, or if so, then with laminate series of short bristles or setulae 2
2. Hind tibiae with a short bristle near base on anterodorsal surface; thorax and abdomen black, the abdomen with pale hind margins to tergites; scutellum with four bristles ..... *nigrita*, n. sp.
   Hind tibiae without any distinct bristles except at apices 3
3. Scutellum with only two strong bristles; hind tibiae without distinct flattened dorsal stripe, with a rather pronounced dorsal ridge which is evenly setulose; fore tibia with two or three short isolated bristles on anterodorsal surface; thorax and abdomen black ..... *atratula*, n. sp.

Scutellum with four well developed bristles; hind tibiae with very evident dorsal flattened stripe which has numerous laminate series of short black setulae; fore tibia with one long bristle, and beyond it a series of very short setulae, on anterodorsal surface; thorax fulvous-yellow, scutellum black; abdomen fulvous-yellow, conspicuously marked with black ..... *nigroscutellata*, n. sp.

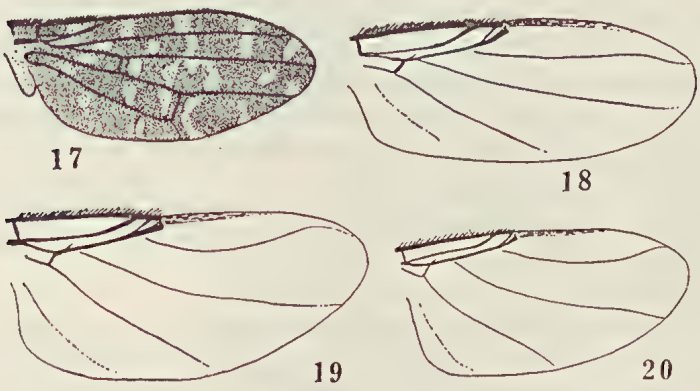
DOHRNIPHORA SETITIBIA, n. sp. Text-figure 18.

Male.—Yellowish testaceous, the head more yellow. Abdomen with a small spot on each side of first tergite, a large transverse spot on each side of tergites 2 to 5 inclusive, and a transverse spot on sixth tergite, black; hypopygium largely dark, the apical process yellow. Mid coxae with a large black mark behind; hind femora hardly darkened apically. Wings brownish hyaline. Halteres dusky-yellow.

Frons longer than wide, subopaque, with numerous piliferous punctures, the postantennal pair of bristles close together, anterior transverse series of four bristles straight, posterior series with the outer one on each side a little in front of median pair; ocellar region black; antennae normal; arista subnude; clypeus produced as far as anterior margin of frons; one bristle close to lower anterior margin of eyes, and two much longer bristles on posterior portion of each cheek; palpi rather large and wide, setulose at apices; proboscis short. Thorax normal; one bristle above and behind, and two below, prothoracic spiracle, and two on lower margin of propleura; scutellum short, slightly rounded apically, the median pair of bristles a little shorter than the lateral pair. Hypopygium smaller than usual, without long bristles on sides. Fore tibia with a stout median bristle, and beyond it a series of very short setulae, on anterodorsal surface; mid tibia normal except in having one or two very short stout setulae near middle on anterodorsal surface, the dorsal surface flattened and with a few microscopic hairs; hind femur normal; hind tibia flattened on dorsum, with some microscopic hairs on flat part, and three or four anterodorsal and anteroventral bristles which are not longer than the tibial diameter. Wing as in Figure 18.

Length, 3.5 mm.

Type, Sydney, N.S.W., June, 1921.



Text-figure 17.—*Limnellia maculipennis*, n. sp. Wing.
Text-figure 18.—*Dohrniphora setitibia*, n. sp. Wing.
Text-figure 19.—*Dohrniphora nigrita*, n. sp. Wing.
Text-figure 20.—*Dohrniphora atratula*, n. sp. Wing.

DOHRNIPHORA NIGRITA, n. sp. Text-figure 19.

Male.—Shining black. Antennae except apex of third segment, the palpi, and proboscis, fulvous-yellow. Abdomen opaque-black, the apices of tergites narrowly clay-coloured. Legs obscure tawny-yellow. Wings greyish hyaline, slightly infuscated on apical half of costal margin. Halteres yellow.

Frons wider than long, the setigerous punctures sparse in centre, postantennal bristles strong and divergent, the frontal bristles as in previous species; head otherwise as in that species. Thorax differing from last in having about four bristles on lower margin of propleura, and the median pair of scutellar bristles longest. Hypopygium large, with a few long fine lateral bristles. Fore tibia as in *setitibia*; mid tibia without the short anterodorsal setulae; hind tibia with but one subbasal short bristle, and with many series of diagonal laminate setulae on the flattened dorsal stripe. Wing as in Figure 19.

Length, 3.5 mm.

Type, Sydney, N.S.W., 28.10.23.

DOHRNIPHORA ATRATULA, n. sp. Text-figure 20.

Male.—Black, shining. Antennae fuscous, palpi yellow. Abdomen with very faint pale hind margins to tergites. Legs fuscous, more yellowish on fore coxae and tibiae and tarsi. Wings greyish hyaline. Halteres yellow.

Frons subquadrate, slightly, evenly convex, almost impunctate, and sparsely haired, bristles as in previous species, but the upper series practically straight, head otherwise much as in *nigrita*. Thorax with two bristles on lower margin of propleura, the scutellum with a strong bristle on each side, and basad of each of these a weak short hair. Fore tibia with two or three short anterodorsal bristles; hind tibia without a flattened dorsal stripe; these characters link the species with *mordax* Brues, described from Formosa, to which it is closely allied, but it differs very strikingly in colour from that species. Wing as in Figure 20.

Length, 1.75 mm.

Type, Sydney, N.S.W., 8.1.23.

DOHRNIPHORA NIGROSCUTELLATA, n. sp.

Male and female.—Fulvous-yellow, shining. Head black, antennae, face, palpi, and sides of mouth, yellow. Scutellum subopaque-black, the dark colour at times suffusing hind part of mesonotum and postnotum. Abdomen in male with paired black dorsal spots, which sometimes unite centrally leaving only the hind margins of the tergites yellow or testaceous; hypopygium black, apex of apical process yellow; in female the basal two or three tergites are fulvous-yellow, the remainder opaque-black, the black part without distinct chitinous plates on dorsum. Legs yellow, hind femora sometimes dark at apices posteriorly. Wings yellowish, their apices more or less infuscated.

Head similar to that of *nigrita*; the clypeus of female produced, and proboscis of same sex chitinous and elongated as is usual in females of this genus. Other characters much as in *nigrita*.

Length, 2.5-3.5 mm.

Type, male, allotype, 3 male and 1 female paratypes, Sydney, N.S.W.

Family Drosophilidae.

LEUCOPHENGA FLAVOHALTERATA, n. sp.

Male.—Head testaceous-yellow, ocellar spot, upper half of frontal orbits, occiput except its lower third, and palpi, fuscous; frons reddish-brown posteriorly. Thoracic dorsum reddish-brown, darker behind; pleura stramineous; scutellum

fuscous, the apex narrowly yellow margined; postnotum fuscous. Abdomen shining black, base of first complete tergite yellow, that of second with a large transverse yellow spot on each side of anterior margin, broad at lateral curvature, not extending to lateral margins, and almost obsolete, or connected by a mere line, centrally; fifth tergite with a yellow central mark. Legs stramineous, knees of mid and hind pairs inconspicuously brownish. Wings brownish hyaline, costa quite obviously brown, most distinctly so at apex of first vein and along costa for some distance before apex of second vein. Halteres pale yellow.

Frons about one-third of the head width, narrower anteriorly; palpi not widened; facial carina subobsolete. Thorax normal. Wing normal.

Length, 2.5 mm.

Type, Cronulla, N.S.W., December, 1924; paratype, Waterfall, N.S.W., January, 1925 (H. Petersen).

This is the only Australian species known to me in which the wings are marked and the halteres unicoloured yellow.

Family Agromyzidae.

Subfamily Ochthiphilinae.

PSEUDOLEUCOPIS FASCIVENTRIS, n. sp. Text-figure 21.

Male.—Black, densely whitish-grey pruinescent. Antennae and palpi black; frons entirely pruinescent. Thorax not vittate. Abdomen with a broad deep black fascia on basal half of each tergite which does not extend over the lateral curve, these fasciae very conspicuous when the abdomen is viewed from directly above, and from in front they appear greyish-brown and but little darker than the grey portions of tergites. Legs black, basal segment of fore tarsi and basal two segments of mid and hind tarsi yellow. Wings hyaline. Halteres yellow.

In structure and chaetotaxy similar to the two known species of the genus, but the third antennal segment is quite sharply angulate on upper apical extremity, and evenly rounded below.

Length, 2.5 mm.

Type and two paratypes, Waterfall, N.S.W., January, 1925 (H. Petersen).

A slightly larger male from Cronulla, N.S.W., taken in December, 1924, by the same collector, has the abdominal fasciae continued over the lateral curves of tergites to, or almost to, the extreme lateral margins of tergites. In other respects it agrees very well with the type, though it may represent a distinct species.

Both the previously described species have the abdomen shining-black, with only faint brownish dusting when seen from behind.

The subfamily Ochthiphilinae is very similar to Sapromyzidae, but in no species of the former are there distinct preapical tibial bristles, the arista is never plumose, and the mesopleura is normally bare.

Family Chloropidae.

Subfamily Botanobiinae.

Genus Batrachomyia Skuse.

Generic characters.—Differs from the other Australian genera in the sub-family in having the mesopleura with numerous long soft hairs on upper posterior part.

Two new species of this genus are in the material before me from Australia, and I have beside me two others from Tasmania. The species are very much the same in structure, but differ markedly in colour. I give below a diagnosis of the characters for distinguishing the new species from Australia.

Synopsis of Species.

A. Third antennal segment entirely, or almost entirely, deep black; hairs on femora nearly all black ..... *atricornis*, n. sp.

AA. Third antennal segment, palpi, and all femoral hairs yellow ..... *flavicornis*, n. sp.

Batrachomyia atricornis, n. sp.

Male and female.—Head orange-yellow, with slight whitish or yellowish dusting, opaque, a large spot over ocelli and the third antennal segment black; palpi black or yellowish. Thorax brownish testaceous, shining, with slight traces of darker dorsal vittae, pleurae and postnotum nowhere black. Abdomen concolourous with thorax, paler basally, dark brown apically. Legs a little paler than the thorax. Wings greyish hyaline, slightly tinged with yellowish-brown basally. Hairs mixed, black and yellowish, those on femora mostly black, dorsum of thorax usually with a central stripe of pale hairs. Halteres fulvous.

Vertex projecting behind posterior level of eyes when seen from above, the posterior ocelli a little behind level of eyes, the declivitous part of occiput as far behind these as they are from anterior ocellus; entire frons with rather dense erect black hairs; eyes higher than long, hairs pale; cheek fully as high as third antennal segment, pale-haired below, vibrissal angle black-haired; antennae small, third segment higher than long; arista thick basally, densely clothed with microscopic appressed black pubescence. Dorsum of thorax rather densely haired, the surface appearing slightly punctate, notopleural region devoid of fine hairs but with four or more fine black bristles posteriorly; scutellum thick and convex, almost bulbous, haired as mesonotum and without differentiated bristles. Abdomen ovate, quite densely haired. Legs stout, hairy; sensory area on hind tibia distinct. Wings large, venation as in Figure 21.

Length, 5.5-7 mm.

Type, allotype, and two paratypes, Sydney, N.S.W., 14.9.24, and 6.10.24.

The two taken on latter date have the palpi yellowish, but I can distinguish no other differences between them and the others. The type has the palpi black.

Batrachomyia flavicornis, n. sp.

Male.—A paler species than *atricornis*. In addition to the characters listed in the key, it differs in having the ocellar dark spot smaller, not extending beyond the ocelli, and less intensely black; the hairs on cheeks are all pale; the vertex is not so much extended backward; the ocelli are slightly proximad of the hind margins of eyes; there is a large black mark on the sternopleura; and the apical hairs on scutellum are more differentiated.

Length, 6 mm.

Type, Kosciusko, N.S.W., 7.12.22 (Nicholson).

The two Tasmanian species of the genus will be described in a paper dealing with the Chloropidae of that island which is now ready to send to the press.

Genus Benjaminella novum.

Generic characters.—Most closely related to *Cestoplectus* Lamb, having the frons above antennae and in front of frontal triangle depressed or flattened, the front of head being almost vertical from anterior portion of triangle to mouth in the male, less obviously so in female, with a slight convexity in profile only at antennae in the former sex. The distinctions between this genus and *Cestoplectus* are as follows: each orbit with three or four short black bristles, none in *Cestoplectus*, notopleura with one anterior and one posterior bristle, not

two posterior; thorax with one pair of prescutellar dorsocentrals, not none; second and third wing veins bare, haired either above or below in *Cestoplectus*.

Genotype, the following species.

BENJAMINELLA ALBIFACIES, n. sp. Text-figure 22.

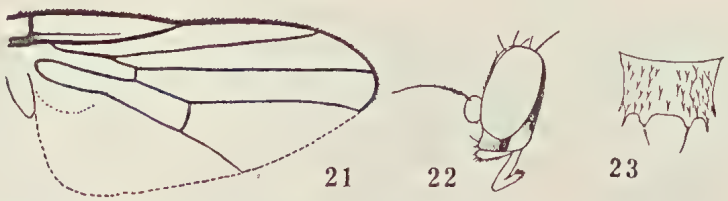
Male and female.—Frontal triangle, the section of frons between same and eye on its hind section, and occiput except lower third black, declivitous part of frons, and the antennae lemon-yellow, face and palpi white, the colours not so strikingly contrasted in females; proboscis and cheeks yellow, the latter with a large reddish mark on anterior half; arista black; cephalic hairs yellow. Thorax glossy-black, humeri mostly yellow, notopleural margin whitish-yellow, postalar callosity and tip of scutellum yellow. Abdomen black, yellowish at base and below. Legs black, coxae yellowish in part, tibiae apically, and tarsi basally, brownish-yellow. Wings hyaline. Knobs of halteres yellowish-white.

Vertical bristles rather pronounced, ocellar pair minute; triangle broad, ocellar region elevated; declivitous part of frons with a depressed central line; lunule transverse; antennae spread apart sideways in male, third segment orbicular; arista very slightly pubescent, fully as long as declivitous part of frons; profile as in Figure 22; palpi quite large, slender. Mesonotum with quite dense short decumbent black hairs; scutellum semicircular, disc haired as mesonotum, with two long and two short marginal bristles. Abdomen tapered apically, male hypopygium quite large, the left clasper long and slender, curved across ventral surface. Legs slender, normal. Wings normal for the group, inner crossvein a little before apex of first vein; second section of costa fully twice as long as third; last section of fifth vein distinctly longer than penultimate section of fourth, and twice as long as outer crossvein.

Length, 2 mm.

Type, male, and allotype, Sydney, N.S.W., 29.10.24, and 28.9.24. Paratype male, Wilmot, Tasmania, 8.1.23 (A. Tonnoir).

The genus is named in honour of Dr. Marcus Benjamin, editor of the Proceedings of the United States National Museum.



Text-figure 21.—*Pseudoleucopis fasciventris*, n. sp. Wing.
Text-figure 22.—*Benjaminella albifacies*, n. gen. et sp. Head of male, in profile.
Text-figure 23.—*Tricimba scutellata*, n. sp. Scutellum from above.

Genus TRICIMBA Lioy.

TRICIMBA SCUTELLATA, n. sp. Text-figure 23.

Male.—Shining-black; frons, except the triangle, opaque, its front margin, face, cheeks, palpi, and antennae except upper margin of third segment, testaceous-yellow; lateral margins of mesonotum and upper half of pleura in middle, slightly grey pruinescent; dorsum of abdomen brownish; legs yellow; wings hyaline; halteres yellow, knobs whitish.

Frons fully half of the head width, with short stubbly bristles, triangle broad, smooth, extending fully to middle of frons; eyes hairy; antennae short, third segment higher than long; arista slender, microscopically pubescent, second segment more than four times as long as thick and about one-third as long as third; face not carinate in middle; vibrissal angle very little produced, cheek about one-seventh of the eye height; proboscis geniculated, but not slender. Thorax with the three impressed longitudinal lines consisting of single series of punctures, the bristles and hairs luteous; scutellum as in Figure 23. Legs normal. Second costal division about 1.5 as long as first, third about as long as first; penultimate section of third vein equal in length to penultimate section of fourth and about half as long as ultimate section of fifth.

Length, 1 mm.

Type, Sydney, N.S.W., 9.8.24.

Distinguished from *carinata* Malloch by the smaller size, noncarinate face, shape of scutellum, etc.

Genus Botanobia Lioy.

This generic name has been used by several writers on the family to supplant *Oscinis* of authors, not Latreille, the latter's genus belonging to the subfamily Chloropinae. Becker proposed for the same purpose the new generic name *Oscinella*. European authors generally disregard Lioy's work and Becker does not accept *Botanobia*. Which name is really valid has not been definitely decided, and this is not the place to discuss the matter, but the concepts are the same.

The genus has the costa continued to apex of fourth vein; scutellum normal in form and armature; hind tibia without a curved apical spine, and with distinct sensory area; only one or two pairs of posterior dorsocentrals on mesonotum; arista pubescent or bare; proboscis not slender or conspicuously geniculated.

The most widely distributed and common genus of the family. Some of the species, such as *frit* Linn., are of considerable economic importance, feeding in the larval stages in the stems of cultivated grains and grasses.

I present descriptions of two outstanding species in this paper, intending to supplement this with descriptions of all the Australian species and a full specific synopsis in a future paper.

Botanobia nigroannulata, n. sp.

Female.—Head yellowish testaceous, frons and antennae more yellow, centre of occiput broadly black, with a black central stripe extending upward to the large black ocellar spot; inner mouth margin black on sides. Thorax yellow testaceous, with five dorsal black vittae, the median one broad, tapered posteriorly, not extending to hind margin, and connected broadly with the narrower submedian vittae in front of suture, these also not extending to hind margin; lateral vittae not extending in front of suture; pleura with a spot at anterior spiracle, a stripe over lower margin of mesopleura and pteropleura, the lower half of sternopleura, and a mark on hypopleura, black; scutellum black on disc; postnotum black. Abdomen pale testaceous-yellow, each tergite black on apical half or more. Legs testaceous-yellow, a spot on base of fore coxa, a broad ring on middle of each femur, a band near apices of fore and mid tibiae, and apical half of hind tibia, apical three segments of hind and apical two segments of mid tarsi black. Wings clear. Halteres yellow.

Frontal triangle not extending beyond middle of frons; surface hairs on frons numerous and black; eyes hairy; arista with very short pubescence; cheek not as high as width of third antennal segment. Thorax quite densely short-haired;

prescutellar acrostichals lacking; scutellum sparsely haired, with four distinct bristles. Legs rather slender, apices of hind tarsi slightly broadened. Outer cross-vein about twice its own length from inner, and more than that from apex of fifth vein.

Length, 2.75 mm.

Type, Sydney, N.S.W., 21.9.24. Paratype, Sydney, 6.11.21.

The paratype has the median and submedian thoracic vittae extending to hind margin, and the fore and mid tarsi more infuscated than in type.

BOTANOBIA DILATA, n. sp.

Male and female.—Similar to the preceding species. Differ as follows: Disc of thorax normally with the black vittae fused, the scutellum less broadly black; pleura with a greater amount of black; the annuli on legs very much reduced, usually mere spots on one surface only, often absent on tibiae, the apical black part of hind tarsi more intense, and not extending to base of third segment; and the apices of palpi and third antennal segment are infuscated.

Structurally similar to preceding species, but the apices of hind tarsi are more conspicuously dilated.

Length, 2-2.75 mm.

Type, allotype male, one male and two female paratypes, Sydney, N.S.W., October and November, 1924; one female, 24.2.25.

Family Muscidae.

Subfamily ANTHOMYIINAE.

Genus FUCELLIA Rob.-Desv.

In a recent lot of material sent to me by Dr. Ferguson there is a male specimen belonging to a species of this genus. I did not include *Fucellia* in my key to the genera of this subfamily in a recent paper because its occurrence in Australia was unknown to me.

The genus may be distinguished from all three previously listed Australian genera of the subfamily by the equally wide frons in both sexes, which occupies one-third of the head width, and has a pair of cruciate interfrontal bristles in both. There is a series of short, but distinct, rather widely spaced bristles on the underside of the costal vein from apex of first vein to about apex of second, a character which is very rare in Muscidae; there are no distinguishable fine hairs on the under surface of the scutellum, a very rare character in the subfamily Anthomyiinae. The hind tibiae have at least three posterodorsal bristles, the lower calyptra is not produced as far as the upper, and the arista is subnude.

The larvae usually feed upon seaweed, but one species destroys the eggs of a small marine fish, the Grunion, occurring on the Pacific coast of North America, which are deposited in the sand in a peculiar manner at high tide so that they are well above the normal high water mark. Adults of many species are very common on the seashore in most parts of the world, though they also occur on the shores of lakes and rivers many miles from the sea.

FUCELLIA MARITIMA Haliday.

This species is distinguished from its allies by the presence of a setigerous process at base of hind femur below in male, and the yellowish palpi and tibiae in both sexes.

Length, 5-6.5 mm.

A very widely distributed species in temperate regions. The specimen before me is from Sydney, N.S.W., January, 1925.

Subfamily Phaoniinae.

Limnophora narrandera, n. sp.

Male.—Black, densely lead-grey pruinescent. Frons when seen from behind with the triangle and orbits grey pruinescent, the interfrontalia opaque black. Thoracic dorsum in type with a partial dark brown central vitta, the lateral vittae absent; scutellum with a small brown spot at base in centre, this mark probably variable. Abdomen with a pair of irregularly subtriangular, fuscous spots on each of the first three visible tergites, which extend over their entire length, but are linear anteriorly on each segment, these spots hardly visible on fourth tergite. Legs black. Wings hyaline. Halteres yellow. Calyptra white.

Frons at vertex about one-third of the head width, narrowed anteriorly, orbits narrow, with an inner series of strong bristles and numerous long erect lateral hairs; parafacials linear in middle; vibrissal angle hardly produced; cheeks with numerous long hairs, some hairs above vibrissae; antennae extending about three-fourths of the distance to mouth; arista with some distinct hairs basally which are about as long as its basal width; cheek almost linear; eye about twice as high as long. Thorax with 2 + 3 dorsocentrals; numerous erect hairs on disc, about six series between the dorsocentrals. Abdomen narrowly ovate. Fore tibia without median posterior bristle; mid tibia with one posterior median bristle; hind femur without distinct ventral bristles; hind tibia with one anteroventral and one anterodorsal bristle. Penultimate section of fourth vein barely longer than outer crossvein and about half as long as ultimate section; first vein bare; first posterior cell slightly narrowed apically.

Length, 4.5 mm.

Type, Narrandera, N.S.W., 24.3.25.

This species will run down to *divergens* Malloch in my recently published key to the species of this genus. It is readily distinguished from that species by the more conspicuously haired orbits; distinct hairs on the arista; less produced vibrissal angle; much more conspicuously haired and less evidently marked dorsum of thorax; uniformly grey scutellum, which in *divergens* is largely velvety-black; less clearly defined abdominal spots; and unclouded crossveins of wings. The anterior intraalar in *divergens* is strong, whereas in the new species it is absent.

Subfamily Lispinae.

Lispa uniseta Malloch.

I described this species from the female only. In a recent lot of specimens Dr. Ferguson sent two specimens of each sex thus enabling me to characterize the male. This sex will run to caption 7 in my recently published key to the species of the genus. It is readily distinguished from both species included there by the presence of but three strong pairs of dorsocentrals on thorax (1 + 2); the armature of hind femur, which consists of two or three short fine bristles on basal half of anteroventral and posteroventral surfaces; and the colour of the apices of mid tibiae, which are whitish. The females have this last feature less distinct.

Length, 5-5.5 mm.

Localities, Narrandera, N.S.W., 24-25.3.25; and Gunnedah, N.S.W., 1.5.25.

THE INFLUENCE OF CERTAIN COLLOIDS UPON FERMENTATION. Part ii.

By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.

[Read 30th September, 1925.]

It was shown in Part i of this series that certain mineral and other colloids accelerated the fermentation of citrate and of the slowly fermentable carbohydrate, lactose, by the high temperature organism. The work in the main was in agreement with results obtained by investigators who had tested other bacteria and the case seems clear so far as the bacteria are concerned. It, however, seems peculiar that other living organisms such as yeasts are not affected in the same way. Söhngen found that while colloids generally had no influence upon the activity of yeast, the bio-colloids, such as peat, paper, charcoal and soil, hastened the alcoholic fermentation by assisting the elimination of the carbon dioxide from the fermenting fluid. He used five grams of pressed yeast with 100 c.c. of 10 per cent. dextrose and it is perhaps to be expected that the dispersal of the carbon dioxide would be advantageous in a rapid fermentation such as this would be.

As it did not seem reasonable to expect that the mineral colloids would really differ in their behaviour towards bacteria and yeasts, a few tests were made to see how far Söhngen's conclusions were justified. The apparatus used for determining the production of carbon dioxide by the high temperature organism was still in commission and it was used in some tests for ascertaining the influence of a colloid upon the fermentation of dextrose by yeast. The results, however, were not sufficiently consistent to enable any deduction to be made.

If we assume that the colloid acts by adsorbing the cellular enzymes and also the fermentable substrate, it is easy to understand that they would have no influence upon the endo-cellular enzyme, zymase. Yeasts, however, possess some extra-cellular enzymes and one of them is invertase. It is possible that if yeast were grown with sucrose, the colloid might hasten the activity of the invertase and the larger amount of the resulting invert sugar would give rise to an increased production of carbon dioxide.

The matter was tested and two small experiments, one with silica, the other with asbestos, were in favour of the idea. A third test may be given *in extenso*. It was made with 0.5 gram of saccharose and 0.2 gram of activated silica in 30 c.c. of dilute yeast water containing 0.2% of potassium phosphate and 0.1% of magnesium sulphate. The pH value was brought to 6.2. A few drops of a well distributed suspension of distillery yeast were used, the same number of drops being added to each flask.

The experiment showed that silica brought about an increased production of carbon dioxide upon the second and third days. It had apparently assisted the yeast invertase to invert the sucrose. In its way, this result with yeast is in agreement with the previous experiments with the high temperature organism.

Table i.—The Influence of Silica upon the Inversion of Saccharose and subsequent Fermentation of the Invert-sugar by Yeast.

Daily yields of carbon dioxide in mg. at 24°.

Days	1	2	3	4	5
Silica, 0.2 gram	54	131	67	12	2
	54	129	71	11	2
	55	127	60	18	2
Average	54	129	66	14	2
Control (no Colloid) ..	58	111	57	17	9
	54	110	51	31	14
	55	110	57	31	7
Average	56	111	55	26	10

The effect of a colloid upon the inversion of saccharose was then tested directly by noting the disappearance of saccharose. Two flasks each with 450 c.c. of nutritive fluid containing 20% of saccharose were seeded each with three drops of a well distributed suspension of a distillery yeast. One flask received 0.5% of asbestos as the colloid. By a mistake the flasks were incubated at 38° during the first day instead of 30° as was intended, but as the inversion appeared to be progressing favourably, the flasks were maintained at the higher temperature. The sugars were estimated according to the routine followed by Lane and Eynon (*Journ. Soc. Chem. Ind.* 1923, 32T.), the only modification being in the use of a flask provided with a cork pierced with three holes, one for the nozzle of the burette, one for introducing the methylene blue, and the third holding an angular tube as a steam get-away.

Table ii.—The Influence of Asbestos on the Inversion of Saccharose by Yeast at 38°.

Days	Start	1	2	3
Asbestos, saccharose inverted	—	8.3	13.8	14.2
saccharose not inverted ..	20	11.3	3.0	0.5
Control, saccharose inverted	—	6.2	10.3	10.3
saccharose not inverted ..	20	13.3	6.5	3.8

The rate of disappearance of the saccharose shows that the colloid had a decided influence in accelerating the inversion activity of the yeast.

A confirmative test was made with silica as the colloid and the temperature was maintained at 30° instead of at 38° as in the last case.

The influence of the colloid is not so clearly shown in this as in the last experiment. It may be the difference of the colloid but it is more likely the effect of the difference in the temperature. Invertase has its optimum working temperature between 55° and 60°, and it is to be expected that the nearer the fermentation temperature is to this the greater will be the inversion.

Table iii.—The Influence of Silica on the Inversion of Saccharose by Yeast at 30°.

Days	Start	1	2	3	4	5	6
Silica, saccharose inverted ..	—	1.3	4.0	8.7	10.4	11.2	10.3
saccharose not inverted ..	20.2	18.3	—	8.8	5.2	3.4	1.2
saccharose unaccounted for	—	—	—	2.7	4.6	5.6	8.7
Control, saccharose inverted ..	—	1.2	3.8	8.2	10.0	10.9	10.5
saccharose not inverted ..	20.2	18.9	—	9.5	6.1	4.0	1.6
saccharose unaccounted for	—	—	—	2.5	4.1	5.3	8.1

The last two experiments confirm the previous finding that colloids such as asbestos and silica, accelerate the activity of organisms which secrete extracellular enzymes such as invertase.

In summing up the last table and noting the saccharose unaccounted for, presumably to form alcohol, carbon dioxide, glycerin and fixed acids, it would seem that the colloid did to a certain extent increase the production of alcohol and carbon dioxide.

As the point was of some importance, it was decided to test the matter by the disappearance of dextrose during its fermentation in the presence and absence of a colloid.

A test with the same nutritive fluid blended with glucose-syrup instead of saccharose showed a slightly greater disappearance of the dextrose from the third to the fifth day. Although less sugar disappeared from the control fluid, it seemed to be fermenting more freely. The foam on its surface was more persistent and when filtered to eliminate the carbon dioxide it was always more cloudy than the test fluid. Possibly the yeast cells had agglomerated on the particles of silica, but such could not be demonstrated microscopically nor was there any pronounced agglutination of the yeast cells in either of the fluids.

It seemed that the method of conducting the last experiment could be improved upon. The fermentation of the control fluid was apparently different from that of the test with the colloid and it seemed possible, in spite of a vigorous shaking just before drawing off the portions, that more yeast cells might have been abstracted from the control than from the test.

In the next experiment, the medium was divided into 50 c.c. portions contained in 100 c.c. conical flasks and whole portions were taken for the dextrose determination. The medium used was the same as the last, with the addition of 0.25% peptone, that is to say it contained starch-glucose syrup 360 grams, yeast water 100 c.c., monopotassium phosphate 2, anhydrous magnesium sulphate 1 and peptone 2.5 grams per litre. The pH value was brought to 6.0. The progeny from a single cell of a recently obtained pressed yeast was distributed in Hansen's fluid and six drops were added to each flask.

Table iv.—The Influence of Silica upon the Fermentation of Dextrose. Percentage of dextrose consumed.

Days	2	3	4	5	7
Silica, 0.25%..	47	53	55	58	68
Control	43	50	51	53	58

There was an increased consumption of the dextrose under the influence of the silica and it was maintained throughout the experiment.

The controls always had more foam on the surfaces of the fluids and this led to testing the viscosity of a fermenting solution containing starch-glucose. There was a slightly increased viscosity in the test containing silica but in view of the fact that the starch-glucose contained much dextrin, the experiment was repeated at a later date when fuller's earth was used as the colloid and commercial dextrose, containing 75% of dextrose, as the sugar. The medium was the same as that used in experiment iv, with the substitution of 16% of commercial dextrose for the starch glucose. Two flasks were used, each with 500 c.c. of medium; one received in addition 2.5 grams of fuller's earth. The seeding was a five days' culture at 28° of a distillery yeast in Hansen's fluid. The supernatant liquid had been decanted and replaced with diluted meat extract; the cells were broken apart and uniformly distributed by repeated passage through a capillary nozzle. Eight drops (about 0.25 c.c.) were added to each flask.

During fermentation, the control fluid carried more froth than the test and foamed strongly on being shaken; the test carried little froth and foamed slightly. On the second day, the test contained 7.08% of dextrose and the experiment was concluded on the third day. The fluids were filtered through paper, then through paper pulp in order to obtain brilliant solutions.

Table v.—The Influence of Fuller's Earth upon the Viscosity and Alcoholic Fermentation of Dextrose. Three days at 28°.

	Control	Fuller's earth
At start—		
Dextrose	11.75	11.75
At end—		
Dextrose	6.01	2.83
= Dextrose consumed %	49	76
Alcohol by weight	2.64	4.13
Viscosity (water = 1)	1.246	1.257

The viscosity of the test fluid was greater than that of the control, but as there was a difference of only ten seconds in the run of 18½ minutes by the 100 c.c. of liquid through the capillary nozzle, the difference is too small to explain any retention of carbon dioxide during fermentation. The difference in the dextrose consumed is the greatest that has been noted in these experiments with yeast. It was possibly due to the seeding cells being five days old and in consequence perhaps slightly enfeebled. The stimulating influence of the colloids upon enfeebled bacterial cells has been already noted.

It has been seen that silica hastened the fermentation of dextrose and it remained to show that the other insoluble colloids did the same.

The medium used was much the same as in the previous experiments and consisted of commercial glucose 100 grams, yeast water 100 c.c., potassium dihydrogen phosphate 5 grams, magnesium sulphate anhyd. 1 gram, and peptone 2 grams per litre; the reaction was brought to pH 6.0. The fluid when prepared contained 7.5% of dextrose. Three hundred c.c. portions were pipetted into a number of 500 c.c. flasks and with the exceptions of the agar and the controls each received 1.5 grams of colloid. Ten drops of a uniformly distributed suspension

of a distillery yeast were added to each flask. Set 1 was incubated at 37° but, as the fermentation seemed to have been too quick and it was hoped to obtain wider differences with a slower fermentation, the flasks of set 2 were incubated at 28°.

Table vi.—The Fermentation of Dextrose by Yeast. Percentage of dextrose consumed.

Set 1 at 37°			Set 2 at 28°		
Days	1	2	Days	2	3
Talc, 0.5%	23.9	80.7	Kieselguhr, 0.5%	67.9	91.2
Kaolin, 0.5%	20.9	80.6	French chalk, 0.5% ..	59.7	90.5
Asbestos, 0.5%	19.5	76.3	Agar, 0.2%	47.0	90.0
Fuller's earth, 0.5% ..	22.9	85.1	Control (no colloid) ..	53.3	87.9
Control (no colloid) ..	21.5	72.0			

All the colloids increased the consumption of dextrose, that is, they had hastened the fermentation by one or the other day of observation.

Set 2 incubated at 28° certainly showed greater differences than set 1 at 37°, probably because the fermentation was caught when from 50 to 60% of the dextrose had been fermented.

It was noted that the control of set 1 at the end of the first day contained more carbon dioxide in solution than the others as was evidenced by a more vigorous effervescence when the liquid was discharged upon a filter to eliminate the dissolved gas previous to measuring off the portion for analysis. This would make it appear that Söhngen's idea of the colloids increasing the fermentation by assisting the elimination of the carbon dioxide was correct. The asbestos test with the smaller consumption of dextrose was anomalous. It had a lessened effervescence like the other colloids, but the asbestos fibres had formed a felt-like film on the surface of the fermenting fluid and this had possibly prevented the aeration of the liquid. In set 2 the control test and the agar test, which was viscous, showed most effervescence upon filtration.

A few more colloidal substances were tested in a further experiment in which the peptone was replaced by marmite. The colloids undoubtedly accelerated, although the differences were not so pronounced as in the last table. This might have been caused by the substitution of marmite for the peptone.

Table via.—The Fermentation of Dextrose by Yeast. Percentage of dextrose consumed.

Set 1 at 28°					Set 2 at 37°			
Days	1	2	3	4	Days	1	2	3
Silicic acid, 0.05%	31.9*	50.5*	71.0*	91.7	Wood charcoal, 0.25%	40.3	70.3	91.0
Ferric hydroxide, 0.015%	28.9	52.6	75.8	92.6	Kieselguhr, 0.25% .. Talc, 0.25%	37.5 38.7	70.4 69.4	91.7 91.1
Agar, 0.1%	31.2*	52.6	77.3	93.2	Gelatin, 0.25%	30.8*	63.4*	84.4*
Fuller's earth, 0.25%	27.9	51.7	78.2	92.4	Control (no colloid)..	38.1*	65.1*	86.2
Control (no colloid)	31.1*	50.5*	69.5*	90.0				

The colloidal silicic acid and the colloidal ferric hydroxide were sterilized separately and added to the flasks previous to seeding. The hydroxide was

coagulated at once and the silicic acid separated out during the first day; they acted, therefore, as insoluble colloids.

The tests marked with an asterisk foamed when pipetted on to the filter, the others were still. The foaming does not seem to have much significance, for the first day's results are just the opposite of what should have happened if an excessive amount of carbon dioxide dissolved in the fluid had hindered the fermentation. On the other hand, in set 2 the gelatin test always effervesced when filtered and the amount of dextrose consumed was always lower than the control. So far the evidence is rather in favour of Söhngen's idea.

Agar which tended to hinder the fermentation when present to the extent of 0.2%, accelerated when a smaller quantity was added; the fluid was not so viscous. It is, however, irregular in its action. In another experiment in which 0.05% was used, it acted as a depressant. Its behaviour is under investigation.

Taken as a whole it is clear that certain mineral and other suspended colloids accelerate the activity of yeast. The substances that have been tested with positive results include silica, asbestos, ferric hydrate, talc, kaolin, fuller's earth, kieselguhr, French chalk, agar and charcoal.

The main point that has been brought out is that yeast, like the high temperature bacterium, ferments more actively in the presence of certain suspended colloids. It is true that the effects were not so great, but they were sufficiently pronounced to show that living bacteria and yeasts do not materially differ in this respect.

In my previous work with colloids, use had been made of the high temperature organism and the complete dissolution of a sugar to carbon dioxide had been taken as evidence of the bacterial activity. The work in this paper has shown that a partial dissolution, the inversion of saccharose by yeast, was increased by colloids. Some work that had been done with invertase itself necessitated a confirmation of the accelerating influence of colloids upon inversion by another living micro-organism.

The Inversion of Saccharose by Bac. levaniformans.

The organism chosen was *Bac. levaniformans*, an ally of *Bac. vulgatus*, occurring in sugar crystals in an almost pure condition. There are several races of this organism. One of them, previously described as $\beta\beta$ (Proc. Linn. Soc. N. S. Wales, 1901, 613), was isolated from brewers' crystals.

At the time of their isolation, small crystals of household sugar were examined and found to contain the normal white race. The race $\beta\beta$ grew as a yellow expansion on ordinary nutrient agar and gave no film on bouillon.

A heaped loop of an agar-culture was added to a bouillon-culture and the cells distributed by repeated passage through the capillary nozzle of a pipette. Four drops of the suspension were added to flasks containing 50 c.c. portions of a saccharose medium which consisted of saccharose 80, sodium phosphate 2, potassium chloride 5 and peptone 2 grams in a litre of tap-water. It had been brought to a pH value of 6.8 with dilute hydrochloric acid and had been steamed on six successive days.

After the flasks had been incubated at 37° for a day, it was noted that two of the controls were clear, while the others were turbid. This was again noted in a second experiment and also that some of the controls which had begun to ferment, had more gum than the others indicating that, although they had been seeded with the same number of cells of the same vitality, the onset of fermen-

tation in the control flasks had been irregular. This destroyed the scheme of the experiments. A similar irregularity had been noted in the case of the high temperature organism and had led to the examination of the influence of colloids upon fermentation.

The experience with the tests indicated that the seeding cells should have previously been grown in the same fluid, and also that the gum in the cultures should be eliminated by precipitation with alcohol when preparing the solution for the determination of the sugar. The method adopted was to pipette 25 c.c. of the fermented fluid into a 100 c.c. flask, neutralize it to phenolphthalein and make to volume with strong spirit. After standing overnight, the solution was decanted or filtered off and the alcohol eliminated by evaporation from an aliquot portion. The residual fluid was transferred to a 100 c.c. flask, slightly acidified to methyl-red with acetic acid, treated with lead subacetate, made to volume and filtered into a 100 c.c. graduated jar. After measuring, the filtrate was acidified with dilute acetic acid, treated with an excess of potassium oxalate and filtered. The sugar was determined in the filtrate.

Two experiments were made and the following results were obtained on the second day in each case. By the fourth day the amounts were very much the same at about 80% and are not recorded.

Table vii.—The Inversion of Saccharose by *Bac. levaniformans* in presence of some Colloids. Percentage of saccharose inverted in two days at 37°.

Set 1.		Set 2.	
Fuller's earth	69.0	Talc	58.4
Asbestos	64.7	Kaolin	47.5
Kieselguhr	56.6	Animal charcoal	40.0
French chalk	54.5	Willow charcoal	21.2
Silica	52.4	Control (no colloid)	31.7
Control (no colloid)	48.2		

All these colloids with the exception of willow charcoal accelerated the inversion of sugar. In a future paper I shall show that this form of charcoal does hasten the inversion and is no exception to the fact which seems to be well demonstrated that the mineral and other colloids such as have been tested, accelerate the inversion activity of *Bac. levaniformans.*

Bac. fluorescens liquefaciens is supposed to be able to secrete invertase, but when it was grown in a fluid containing sugar, no inversion of the saccharose occurred.

So far it has been shown that the mineral and other insoluble colloids accelerate the fermentation of dextrose by yeast, the inversion of saccharose by yeast and the inversion of saccharose by *Bac. levaniformans.* It seems to be a stimulation of the cell activity rather than an adsorption of ferment and fermentable substrate upon the colloidal surfaces. To test the matter it was decided to test the activity of a naked enzyme when in contact with the same colloids. The enzyme chosen was the same that had already been under investigation, viz., invertase.

The Action of Certain Colloids upon Invertase.

Invertase was prepared from autolysed yeast in the manner usually recommended and its activity was tested.

One-tenth of a gram of the dry powder was stirred with 10 c.c. of water which was acidified with oxalic acid to a pH value of 4.4. After half an hour the suspension was centrifugalized and the opalescent supernatant fluid was pipetted off. Two c.c. portions were pipetted into flasks containing 25 c.c. of 8% saccharose, 5 c.c. of $^{M}/_{15}$ potassium dihydrogen phosphate and 0.2 gram of colloid. In the cases of gelatinous aluminium hydrate and ferric phosphate 3 c.c. of a 3% suspension were used. Previous to the addition of the invertase, the saccharine fluids with their colloids had been brought to a pH value of 4.4 (pale green with brom-cresol green) with decinormal hydrochloric acid. Some of the colloids absorbed the acid, but the absorption had slowed down by the end of half an hour.

The flasks were then placed in a thermostat at 40° for 45 minutes, treated with 2 c.c. of basic lead acetate, cooled, made to 100 c.c. and filtered; 50 c.c. of the filtrate were treated with 5 c.c. of 10% potassium oxalate, acidified with dilute acetic acid, made to 200 c.c. and filtered. The invert sugar was determined in the filtrate by means of Fehling's solution. About 50% of the sugar was inverted under the conditions.

Preliminary tests showed some variation, but when the method as described was followed it was shown that the colloids had no influence upon the inversion of saccharose. The tests were made in three lots in order to avoid delay between the time of inversion and the determination of the invert sugar.

Table viii.—The Influence of Colloids upon the Inversion of Saccharose by Invertase. Percentage inverted.

Set 1.		Set 2.		Set 3.	
No colloid	53.1	No colloid	47.4	No colloid	49.0
Kaolin	52.7	French chalk ..	47.9	Silica	48.7
Kieselguhr	53.3	Charcoal	47.2	Talc	48.7
Diatomaceous earth	53.1	Asbestos	46.0	Ferric phosphate ..	47.4
Gelatin	53.4			Aluminium hydrate	44.9
Agar powder ..	53.4				

If the individual tests are taken to whole numbers, it will be clearly seen that the colloids were inactive. The low number for the gelatinous aluminium hydrate was probably due to the solution of the hydrate in the hydrochloric acid of which a considerable amount had to be added to bring the solution to pH 4.4.

The indifference of charcoal is in agreement with the work of Griffen and Nelson (*Journ. Amer. Chem. Soc.*, 1916, 722), who found that charcoal, alumina and albumen had no influence upon the activity of invertase.

Since the colloids do not accelerate the inversion of saccharose by invertase itself, it follows that the adsorption of the enzyme, if it does occur, is not the explanation of the efficiency of the colloids with living cells. The matter being of some importance, it was decided to test another enzymic fermentation, that of the decomposition of urea by bacteria and by the enzyme, urease.

The Ammoniacal Fermentation of Urea.

A flask with urea had undergone fermentation and from it a culture of *B. fluorescens liquefaciens* was obtained. It was seeded into flasks containing urea and buffer salts with and without kieselguhr. Six flasks were used, one for each determination of the ammonia by the method which will be described later.

Table ix.—The Fermentation of Urea by *B. fluorescens liquefaciens*.
Percentage of urea fermented.

Days	1	2	4
Control	16.0	18.1	20.6
Kieselguhr	16.3	28.6	43.6

The kieselguhr undoubtedly accelerated the fermentation.

A urea-fermenting organism was isolated from soil. Morphologically it was like *Urobacillus duclauxii* and culturally like *U. pasteurii*.* It grew well at 37° on nutrient agar containing urea.

The bacterium was distributed in dilute meat-extract and an equal number of drops were seeded into twelve flasks, each containing 50 c.c. of a fluid consisting of 1% peptone, 1% urea and 0.5% sodium chloride. The urea was sterilized apart from the other components of the medium. The flasks were in groups of three, each group containing 0.2 gram of suspended colloid, with the exception of one group, which acted as control.

The results of the experiment show that these suspended colloids undoubtedly accelerated the activity of the bacterium.

Using the same organism, tests were made with other colloidal substances. The progress of the fermentation was watched both by the rise in the pH values and by the amount of ammonia found in a special control flask. This was found to be necessary when a progressive determination similar to the previous table was not made; one could not guess just when to stop the fermentation in order to show the effects of the colloids. In the two tests about to be tabulated all the flasks, with the exception of the sterile controls, contained bacteria. The infected

Table x.—The Influence of Colloids upon the Bacterial Fermentation of Urea.
Percentage of urea fermented.

Days	1	2	3
Control	9.6	8.5†	14.5
Asbestos	15.5	51.7	95.6
Kaolin	15.2	31.2	96.0
Charcoal	11.4	20.2	39.0

* A motile rod with rounded ends. 0.6 : 2-3μ with longer and thread forms; spores were terminal and the Gram stain was positive. No growth was obtained on agar or gelatin devoid of urea, although, in bouillon without urea, a slight turbidity developed. In urea bouillon, a strong turbidity was produced. Milk without urea was unaffected. On nutrient agar with urea there developed at 37° a moist glistening translucent expansion. The colonies in urea gelatin appeared as a collection of pale brown lobules radiating from a central mass of small brown granules. These granules also appeared in the medium around the colony. In time the surface colonies became a mass of brown granules (not crystals) in a crateriform apparently liquefied area. The stab in urea gelatin was filiform surrounded by a white haze with little or no surface growth; at a later date (11 days) the gelatin was consumed, leaving a gas bubble, the upper part of the canal was ciliate and the lower part was studded with crystals, a haze was spread through the upper two-thirds of the gelatin.

According to Gellinger (through *Abst. in Bact.* iv, p. 93) the identification of the urea-fermenting bacteria is a matter of some difficulty.

† A large loop of the control of the second day was found to be sterile.

controls of set *a* were bright but they yielded growths of bacteria when sown upon urea-agar slopes and they had the faecal smell characteristic of the bacillus. Set *a* was stopped on the fourth day and set *b* on the third day. As in all previous cases, each flask in each set received the same number of drops of a well distributed culture of the bacillus. A sterile flask was included in each test in order to control the urea decomposed during the sterilization of the media. In set *a* this was equivalent to 4.1 and in set *b* to 4.6% of urea. These percentages have been subtracted from those obtained with the others.

The colloidal solutions of silicic acid and of ferric hydroxide coagulated upon being added to the saline medium; they acted, therefore, as insoluble colloids. The fluids were coloured with phenol-red and all were brought to the same pH value (7.2) before adding the sterile solution of urea.

Table xi.—The Influence of Colloids upon the Bacterial Fermentation of Urea.
Percentage of urea fermented.

Set.		*a.*	*b.*
Silicic acid	0.1 gram	63.2	45.9
Silica	0.2 „	34.5	44.4
Aluminium hydrate	0.1 „	5.4	23.0
Aluminium phosphate	0.1 „	48.6	36.2
Ferric hydroxide	0.05 „	13.1	30.2
Kieselguhr	0.2 „	16.2	30.9
Fuller's earth	0.2 „	35.9	36.8
Asbestos	0.2 „	44.8	12.4
French chalk	0.2 „	7.6	11.7
Agar	0.2 „	6.9	5.4
Gelatin	0.2 „	3.6	11.0
Control (no colloid)		0.6 0.4	8.5 6.9

As a rule the colloids accelerated the fermentation of urea by the bacillus, and although they do not run parallel in each set their action is quite clear. The finely divided precipitate of silica formed on the addition of the silicic acid sol to the culture fluid was the most efficient accelerator.

During the sterilization of the fluids, the agar had softened and had set as a cake at the bottom of the flasks. Before infection the cake was chopped up with a platinum chisel; it acted as lumps of solid agar. After noting the activity of the finely divided precipitate of silica in the silicic acid test it was decided to try the effect of having the agar as a finely divided flocculent solid. Seven flasks were prepared as in the previous tests and in two of them the agar (= 0.2 gram) was shaken up after each sterilization. On cooling it separated in fine floccules. The same weight of agar-fibre was sterilized in test tubes without water and added to their respective flasks just before inoculation. One of the flasks served as a sterile control and gave an amount of ammonia equal to 5.0% of urea; this has been deducted from the other totals.

Table xii.—The Action of Agar in the Bacterial Fermentation of Urea.
Percentage of urea fermented in five days at 37°.

Agar-fibre	16.4 16.9	16.6
Finely divided agar	20.9 21.2	21.0
Control (no agar)	9.1 8.3	8.7

The effect of the subdivision of the colloid is decided, but the difference is not so great as one might have expected. Similarly in set *b* of the previous table, the difference between the finely divided silica and the precipitated silica of commerce is not very pronounced.

The case having been proved for the fermentation of urea by bacteria, the influence of colloids upon urease was tested. Soy beans were used as the source of the enzyme. They were ground to a coarse meal and extracted with petrol. The defatted meal was ground to a fine flour and bottled for use. Two grams of the flour were shaken with 100 c.c. of water in a bottle at intervals during half an hour and filtered. Half a gram of urea was dissolved in 250 c.c. of water and 25 c.c. portions were pipetted into 100 c.c. conical flasks. These were fitted with corks, through each of which passed a rather wide tube holding a small plug of cotton-wool. The plug was subsequently moistened with dilute sulphuric acid and served to trap any ammonia attempting to escape from the flask. Each flask then received 10 c.c. of a buffer mixture of salts of pH value 5.6 and enough methyl-red to colour the fluid. The colloid, 0.2 gram, was added and the flasks were inserted in the thermostat at 40° where they remained for 15 minutes. They were examined and brought to a pH value of 5.6, that is, to a pale brick-red colour by the addition of a few drops of acid or alkali. Two c.c. of the soy bean extract (= 0.04 gram bean-flour) were added to each flask, the plugs were moistened with dilute acid and the flasks returned to the thermostat* where they remained for half an hour.†

The flasks were withdrawn from the thermostat, 5 c.c. of $^{N}/_{1}$ sulphuric acid were added to each, the plugs were pushed in and the tubes were washed into the flasks. The fluids were transferred to 500 c.c. flasks and boiled for 5 minutes to expel the carbon dioxide. After cooling, 1 gram of magnesium oxide was added and the flasks were connected up with condensers and boiled.‡ The distillates

Table xiii.—The Influence of some Colloids upon the Fermentation of Urea by Urease. Percentage of urea fermented.

Set.	1	2	3	4
Control (no colloid)	56	51	55	57
Asbestos	58	51	—	53
Silica	56	—	52	—
Kieselguhr	—	51	—	59
Talc	—	46	51	—
Fuller's earth	—	—	52	50
Charcoal	—	—	56	50
Ferric phosphate	—	—	—	56

* The thermostat consisted of a copper vessel with wires soldered vertically round the top. Each wire slid through the helical spring of an American clothes-peg which gripped the tube passing through cork of the flask. Thus the flasks were safely held while immersed in the water.

† The fluid lost its acid reaction as the ammonium carbonate was formed. A repeated adjustment to pH 5.6 had the effect of slowing the fermentation and was not adopted.

‡ This is a departure from the usual method which consists in adding a definite number of c.c. of standard acid to the fermented urea solution, eliminating the carbon dioxide by passing a current of air through the acidified solution and determining the free acid in the flask. It was found that the colloids absorbed more or less acid, sometimes as much as 1 c.c. (= 6% of urea fermented) and this rendered the method untrustworthy.

were caught in 20 c.c. portions of deci-normal acid and titrated, using Congo-red as the indicator. Controls showed that an allowance had to be made for the magnesium oxide.

The results showed that the controls were generally better fermented than the colloid tests and enough seemed to have been done to indicate that these substances do not accelerate the enzymic fermentation.

In the hope that some further information might be given by a slower fermentation, three tests were made in which the ammonia was determined at half-hourly intervals and in which a variable amount of bean extract was used.

Table xiv.—Varying Amounts of Urease. Percentage of urea fermented.

Ratio of Soy-bean meal to urea.		½ hour.	1 hour.	1½ hours at 40°.
4 : 5	Control	56	100	100
	Kieselguhr	51	91	100
2 : 5	Control	33	61	75
	Kieselguhr	27	56	71
3 : 5	Control	47	77	91
	Asbestos	46	76	91

The graphs of these numbers did not give any further information and the tests simply confirmed the previous work in showing that these colloids, rather than accelerate the fermentation, tended to retard it.

A very weak solution of urease was used in the following sequel to the last experiment.

Table xv.—The Slow Fermentation of Urea by Urease. Percentage fermented.

Days	1	2	3	4
a. Control	18.6	27.9	66.4	66.4
Kieselguhr ..	2.0	5.9	7.9	10.2
b. Control	23.5	40.9	55.9	55.9
Kaolin	17.4	28.6	38.1	40.6

Ratio of Soy-bean meal to urea, 1 : 25.

The slow fermentation exhibits in a more marked manner the inhibiting action of the colloid upon the urease.

We have thus come to the conclusion that the mineral colloids and suspensoids, such as have been used in the tests, assist the fermentation by living organisms such as bacteria and yeasts and depress or tend to depress the fermentation by the naked enzymes, invertase and urease.

Their depressing influence upon the enzymes is doubtless bound up with their faculty of being adsorbed upon the colloid and thus being removed from the mass of the substrate in the supernatant fluid.* The reason for their

* Waksman (*Abstracts of Bacteriology*, vi, 269) in a review of the literature upon the "Enzymes of Microorganisms," writes that enzymes "are readily taken up by finely divided substances such as kaolin, charcoal, infusorial earth, alumina, protein. . . . Adsorbed enzymes are inactive."

accelerating action upon the living cell cannot be explained and it seems reasonable to suppose that since the action is the opposite the *modus operandi* will not be on account of adsorption.

The Lactic Fermentation of Dextrose.

The lactic fermentation of dextrose promised to give further information regarding the influence of the colloids and a set of tests was prepared. The organism used was an acid-former that had been isolated from a liquid suspension of yeasts and bacteria sold by some local firms to bakers for raising their doughs. The preparations are known as spontaneous or "spon" yeasts. The bacterial flora is mixed, but by far the most numerous organism is one which grows feebly on the ordinary solid media, better on media containing dextrose and better still in dextrose nutritive fluids. Several of what were probably races of one organism were isolated; one* of them produced most acid in a modified Hansen's fluid, attaining a pH value of 3.4 as against 3.9 and 4.6 with the others.

The fluid in which the bacterium was grown contained starch glucose 5%, peptone 1%, potassium phosphate 0.35%, sodium phosphate 0.15% and sodium chloride 0.15%. The pH value was 6.6. Fifty c.c. were put into flasks together with 0.25 gram of the colloid except in the case of agar, of which 0.1 gram was taken. The agar liquefied during the sterilization of the flasks, and when the liquid cooled the agar settled out as a lumpy kind of clot.

During the experiment, 5 c.c. of fluid were extracted daily from each flask, coloured with a drop of phenolphthalein and titrated with $^{N}/_{20}$ potassium hydrate until a faint pink colour was obtained. The pink colour disappeared and after an interval of one minute the colour was adjusted with a further addition of alkali. In the experiments with urea, it had been found that the colloids absorbed hydrochloric acid, but in this experiment there appeared to be no absorption of the lactic acid formed by the microbe.

Two experiments were made, the first with a medium containing 0.5% of peptone but as the results were relatively the same as with a medium containing

Table xvi.—The Influence of Colloids upon the Lactic Fermentation of Dextrose. Acidity as c.c. of normal acid per litre of medium.

Time in days	2	3	4	5	6
French chalk	38	58	64	65	68
Talc	39	58	62	63	65
Animal charcoal	38	56	62	63	64
Willow charcoal	36	56	63	65	66
Asbestos	36	53	61	63	63
Fuller's earth	34	51	59	64	65
Kieselguhr	38	53	59	61	64
Silica	37	51	57	61	63
Kaolin	36	51	55	58	63
Control (no colloid)	37	49	56	60	63
Control (no colloid)	36	50	55	59	61
Gelatin	36	48	55	59	63
Agar	32	43	53	59	62

* It is a short rod, almost a coccobacterium, forming small translucent white colonies on dextrose agar. After some subcultivation, it grew rather better, especially on agar containing saccharose and glycerin. Dextrose-agar coloured with brom-cresol purple was rapidly turned yellow, even with the feebly growing cells. Milk was in some instances slightly acidified but never curdled. The acid formed in fluid dextrose media was almost entirely lactic. It grew better at 28° than at 37°.

1%, the second experiment is alone recorded. The figures for the fourth day of the 0.5% peptone test were practically the same as those of the third day with the 1%; the smaller amount of peptone reduced the acidity by about 8%.

The experiment shows that many of the colloids have accelerated the acidification of the fluid. French chalk, talc, the charcoals, asbestos and fuller's earth were the most efficient, while gelatin and agar had no action or depressed the fermentation. The general outcome is that the lactic fermentation falls into line with the other bacterial fermentations which are assisted by the presence of these colloids.

The Influence of Colloids on Diastatic Activity.

The action of malt-diastase upon starch was tested to see if it differed from urease and invertase in its behaviour in the presence of mineral colloids. Preliminary tests with iodine as an indicator showed that the qualitative method was not sufficiently regular in its action to bring forward the results as evidence of the activity or otherwise of the colloids. The actual determination of the sugar resulting from the fermentation promised to be more acceptable.

Two grams of soluble starch were put into a 100 c.c. conical flask along with 50 c.c. of water. The starch was liquefied and upon cooling 5 c.c. of a buffer mixture of salts of pH value 4.9 were added. Two grams of ground malt were digested overnight at 22° in 100 c.c. of water. The clear filtrate was diluted fourfold and 5 c.c. were pipetted into each flask together with 0.2 c.c. of chloroform. The flasks were corked and incubated overnight at 37°. The slow fermentation with the small quantity of malt extract (= 0.025 gram of malt) converted about 60% of the starch and this was considered to be about the extent of change best suited to show the effect of the added colloid, of which 0.2 gram was present in each flask.

Some tests with a larger proportion of malt had given from 75% to 78% of altered starch, but as this is so near the point where starch shows a resting stage or rather a slowing up in the fermentation (*Trans. Guinness Research Lab.* i (1), 87), the smaller quantity was used.

Table xvii.—The Influence of Certain Colloids upon the Saccharification of Starch by Diastase. Maltose from 100 grams of dry starch.

Test	1	2	3
Control	63.2	61.5	64.1
Kieselguhr	25.3	36.9	—
Silica	42.6	50.0	—
Talc	48.1	59.7	50.9
Charcoal	55.4	56.0	—
Asbestos	57.9	49.9	57.9
French chalk	16.7	53.1	31.5
Kieselguhr (local)	9.4	15.6	—
Kaolin	8.0	33.3	9.5
Fuller's earth	9.2	8.8	—
Agar powder	58.7	53.1	—

The results show that the mineral colloids with charcoal and agar not only did not assist the diastase to saccharify the starch, but also that they varied in their activity in depressing the saccharification. This point has been noted, to some extent, by other investigators in regard to certain mineral and organic

colloids. Pincussen (*Bot. Abstracts*, 1924, 692) reported that a number of enzymes including the diastases were depressed by colloidal ferric hydroxide, and Hagihara noted that cholesterol depressed diastatic action.

It is possible that if the enzyme had been allowed to act more slowly, the colloids might have had time to exert some influence.

To test this point, a weaker extract of malt was taken and the tests were incubated at a lower temperature, viz. 37°. The 2% solution of malt was diluted ten times, so that the ratio of malt to starch was 0.5 to 100 as against 1.25 to 100 in the previous table. Twelve flasks were used in the experiment, four controls and four each with asbestos and animal charcoal.

Table xviii.—The Slower Fermentation of Starch by Diastase. Maltose from 100 grams of dry starch.

Days	1	2	3	4
Control	52.3	57.3	62.2	61.0
Charcoal	41.6	48.6	58.9	56.3
Asbestos	37.5	50.2	51.6	56.1

The results are similar to those already obtained and show that, whether by a slow or by a quick fermentation, the colloids such as charcoal and asbestos lessen the activity of the enzyme.

The Influence of Colloids upon the Diastatic Activity of Starch-dissolving Bacteria.

Raw starch contains a number of starch-dissolving bacteria among which are *Bac. mycoides** and *Bac. vulgatus*. The latter is by far the most numerous and a colony was selected for testing the diastatic activity. It turned out to be *Bac. levaniformans*, an ally or race of *Bac. vulgatus*, that produces an opalescent solution of gum-levan when grown in fluids containing saccharose, peptone, sodium phosphate and potassium chloride. The bacillus was grown in a nutrient fluid consisting of 1% of meat extract with 0.15% of potassium phosphate and brought to a pH value of 6.8. Kaolin and asbestos were chosen for testing the hydrolytic effect. As in most of the previous experiments, each test had a flask to itself; there were twelve flasks each containing 50 c.c. of fluid, 2 grams of soluble starch and 0.25 gram of colloid except in the case of the controls.

Although the organism is an active starch dissolver, it did not promise to show well in the experiment for the reason that in bouillon and in meat extract

Table xix.—The Action of *Bac. levaniformans* upon Soluble Starch. Maltose from 100 parts of dry starch.

Days	2	3	4	5
Control	48.5	59.5	62.6	69.0
Kaolin	50.1	64.1	67.2	69.3
Asbestos	48.0	59.1	64.9	68.5

* *Bac. mycoides* and another starch-dissolving bacterium, both isolated from starch, were examined, but they did not seem to be capable of converting soluble starch to maltose. The products of fermentation, after clarification, did not reduce Fehling's solution in a normal manner like maltose. During the boiling the solution became blackish and suddenly turned to a yellow-green colour.

it forms a strong cohesive film on the surface of the fluid, with very little sub-surface growth. If contact between the colloid and the bacterium is a desideratum, it would not occur to any extent with this bacterium. The results were according to promise and the colloids tested had little or no influence. Kaolin did accelerate a little but asbestos did not.

At a later date the matter was again tested with another culture of the same organism isolated from sugar. Each test flask contained 50 c.c. of a medium consisting of meat extract 0.5%, monopotassium phosphate 0.15% and sodium chloride 0.5% brought to a pH value of 6.5. Each flask also contained 2 grams of soluble starch and, excepting the controls, 0.25 gram of colloid. The fermented fluid was transferred to a 200 c.c. graduated flask with the aid of 50 c.c. of water, 6 c.c. of basic lead acetate were added and then strong spirit to volume. After shaking, cooling and adjusting to volume, the fluid was filtered into a graduated jar and a known volume of the filtrate was transferred to a basin, treated with 10 c.c. of 10% potassium oxalate and 0.5 c.c. of dilute acetic acid and evaporated until the spirit had been expelled. The residual fluid was made to 200 c.c. and filtered. The reducing sugar in the filtrate was determined as maltose.* The treatment of the fermented starch with basic lead acetate and spirit was distinctly advantageous in obtaining a clear filtrate.

Table xix*a*.—The action of *Bac. levaniformans* upon Soluble Starch. Maltose from 100 parts of dry starch.

Days	2	3	4	5
Control	16.5	56.4	58.5	55.4
Animal charcoal	19.5	60.2	59.2	59.4
Fuller's earth	31.3	60.8	62.9	59.6
Silica	19.8	56.6	58.8	55.6
Asbestos	17.9	56.9	55.9	53.1

It is evident that the mineral colloids and charcoal have a distinct influence in accelerating the diastatic activity of the bacterium more especially in the early stages of the fermentation. The most indifferent was asbestos which, as in Table xix, had little or no action. Animal charcoal and fuller's earth were the most efficient accelerators.

A test was made to see the action of talc upon the diastatic activity of *Bac. levaniformans*. Two flasks, each containing a litre of medium similar to that

Table xix*b*.—The Influence of Talc in accelerating the diastatic Activity of *Bac. levaniformans*. Maltose from 100 grams of dry starch.

Days	3	4	7	11
Control	42.3	55.6	50.5	38.7
Talc	46.9	55.8	51.3	40.7

* *Bac. vulgatus* is known to produce diastase. Vignal found that it also produced invertase, protease, cytase and rennin. Effront noted that its diastatic enzyme had strong amylolytic and weak saccharifying powers (Waksman, Enzymes of Micro-organisms, *Abstr. of Bact.* vi (1922), 281). Estienne (through *Journ. Soc. Chem. Ind.*, 1925, B184) notes that it also secretes maltase. Judged by the reducing powers of a solution before and after boiling with dilute hydrochloric acid, the sugar formed by the action of *Bac. levaniformans* upon starch was maltose.

used in Experiment xix, were seeded with the bacillus. One flask received 5 grams of gently ignited talc. Portions measuring 100 c.c. were abstracted from each flask from time to time and treated as in Experiment xix*a*.

As with the colloids of Experiment xix*a*, talc shows an accelerating action in the early stages of the fermentation. In addition, it shows that in course of time the maltose becomes consumed and the colloid tends to inhibit this consumption. It is possible that there may be a balance between the formation and the destruction of the sugar and that the impetus given to the formation by the talc makes it appear as if it inhibited the destruction.

The experiments tend to show that the diastatic activity of bacteria, as exemplified by this form of *Bac. vulgatus*, is accelerated by the presence of some mineral colloids and of charcoal. The evidence is not so pronounced as in other cases, but this may possibly be due to the unsuitability of the organism. It may also be due to the fact that starch itself is a colloid and the effect of the additional colloid cannot be so pronounced as when a non-colloid substrate is employed.

Conclusion.

Certain mineral and other colloids were tested to see if they accelerated the fermentation of carbohydrates by yeast after the manner that they hastened the fermentation of certain compounds of carbon by the high temperature organism. Silica induced a quicker production of carbon dioxide in the fermentation of saccharose by a distillery yeast. Asbestos and silica hastened the inversion of saccharose by yeast and silica accelerated the fermentation of dextrose. Wood-charcoal, talc, kaolin, fuller's earth, asbestos, kieselguhr, French chalk and ferric hydrate also hastened the slow fermentation of dextrose. The differences in the relative amounts of fermented material were not so great as when dealing with bacteria, but they were sufficiently marked to show that the yeasts and the bacteria obeyed a rule and were favourably influenced by the presence of these colloidal substances.

The inversion of saccharose by *Bac. levaniformans*, an organism closely related to and perhaps identical with *Bac. vulgatus*, was hastened by the presence of mineral and other colloids, as silica, fuller's earth, French chalk, kieselguhr, asbestos, kaolin, talc and charcoal. The inversion of the sugar by diastase, prepared from yeast, was not influenced by these colloids.

The ammoniacal fermentation of urea by *Bac. fluorescens liquefaciens* was assisted by the presence of kieselguhr. The fermentation of urea by a urobacillus was accelerated by most of the previously named colloids and by agar, gelatin, silicic acid, aluminium hydrate and aluminium phosphate. Agar in floccules was more effective than in the fibrous condition.

These colloids had no influence upon the fermentation of urea by the enzyme urease contained in an extract from the soy bean, and it did not matter whether the fermentation was quick or slow.

The lactic fermentation of dextrose by a lactic bacterium was hastened by most of these colloids; kaolin, gelatin and agar did not act.

The diastatic fermentation of starch by *Bac. levaniformans* was accelerated by kaolin, animal charcoal, fuller's earth and talc. The acceleration was not pronounced, possibly because starch is itself a colloid, but it was sufficient to show that the bacterial fermentation of starch falls into line with other fermentations.

The colloids had an inhibiting influence upon the action of malt diastase on starch.

It is evident that the influence of the insoluble colloids in accelerating the fermentative activities of bacteria and yeasts is not due to the adsorption of their enzymes.

All the colloids were insoluble. When the sols of silicic acid and ferric hydroxide were used, they were coagulated by the salts of the media necessary for the growth of the microorganisms, and therefore acted as insoluble colloids. The soluble colloid, gelatin, feebly stimulated the urobacillus, depressed the alcoholic and had no action upon the acid fermentation of dextrose.

The research has shown that yeasts and bacteria have their fermentative activities accelerated by the presence of certain mineral and other colloids such as talc, kieselguhr, silica, fuller's earth, charcoal and agar and that the isolated enzymes are not influenced by the same colloids.

I am indebted to Mr. W. W. L'Estrange for much kind assistance.

THE HAEMATOZOA OF AUSTRALIAN MARINE TELEOSTEI.

By I. M. Mackerras, B.Sc., M.B., Ch.M., Linnean Macleay Fellow of the Society in Zoology, and M. J. Mackerras, B.Sc., M.B.

(Six Text-figures.)

[Read 30th September, 1925.]

Introduction.

No blood parasites have been recorded from Australian marine fish, which is surprising in view of their common occurrence in other parts of the world. The "ring bodies" described by Johnston and Cleland (1909) from the red blood cells of *Monocanthus* sp. may possibly be protozoa, but their interpretation, that they are centrosomes, is more probably correct. The same authors later (1910) listed 46 marine Teleostei examined with negative results. The findings here recorded serve to bring the Australian haematozoal fauna into line with that of other regions.

While many species of Trypanosomes and Haemogregarines are known from marine fish, blood inhabiting Trypanoplasms have, so far as we can determine, only been recorded hitherto from freshwater fish.

It is a pleasure to acknowledge our indebtedness to the late Mr. A. R. McCulloch of the Australian Museum, Sydney, who has identified most of our host species. The nomenclature followed here is that given in his "Check List" (McCulloch, 1922).

Part of this work was carried out while one of the authors (I. M. Mackerras) was the holder of the John Coutts and Science Research Scholarships in the University of Sydney.

Methods.

Smears were made from the heart blood as soon as the fish was caught, dried as rapidly as possible and stained on our return home either with Leishman's Stain or with a solution of "Soloid" Eosin-Azur in pure methyl alcohol. Both methods were used without previous fixation and the latter gave particularly good results, especially if the staining time was extended (3-5 minutes in undiluted, and 15-45 minutes in diluted stain).

Conditions were such as to preclude the use of wet-fixation methods, which is to be regretted, as many important details of morphology are not seen satisfactorily in dried films. Having in mind the use which may be made of parasites in determining host relationships, we have consequently refrained from discussing the affinities of the parasites here described.

Fish blood is remarkable for the extreme rapidity with which it clots, either in the body after death, or on being drawn from the living animal. Films must therefore be made as soon as the fish is caught, and haste is necessary once the heart is opened in order to obtain even three or four satisfactory preparations.

Material.

The material was collected at Sydney and at Broken Bay, near Sydney, N.S.W., during the past four years at such times as opportunity offered. Fish were examined at all seasons, the majority, however, during the winter, and parasites were found in the months of January, May, June and November. Two hundred fish belonging to 31 species and 27 genera have been examined. The following list gives those species which have been searched with negative results, together with the number of individuals of each species examined. It is to be noted that the infections found have always been scanty, consequently we may have missed an occasional parasite in those smears classified as negative, although each was submitted to a prolonged and careful search.

Acanthistius serratus (Cuv. and Val.). Wirrah	6
Atypichthys strigatus (Gunth.). Mado	1
Cantherines ayraudi (Quoy and Gaimard). Leather-jacket	17
Cantherines hippocrepis (Quoy and Gaimard). Variable Leather-jacket	2
Cantherines sp. (Young). Leather-jacket	5
Cnidoglanis megastomus (Rich.). Estuary Cat Fish	2
Dactylopagrus morwong (Ramsay and Ogilby). Morwong	1
Dicotylichthys punctulatus Kaup. Porcupine Fish	4
Enoplosus armatus (Shaw). Old Wife	3
Hippocampus novaehollandiae Steind. Sea Horse	11
Leptocephalus labiatus (Castelnau). Conger Eel	1
Lotella callarias Gunth. Beardie	1
Neoplatycephalus macrodon Ogilby. Tiger Flathead	1
Ophthalmolepis lineolatus (Cuv. and Val.). Maori	4
Pagrosomus auratus (Forster). Snapper	27
Platycephalus fuscus Cuv. and Val. Dusky Flathead	8
Pseudolabrus gymnogenis (Gunth.). White-spotted Parrot Fish	6
Pterygotrigla polyommata (Rich.). Latchet	1
Sciena antarctica Castelnau. Jewfish	11
Scomber australasicus Cuv. and Val. Mackerel	2
Scorpaena cardinalis Rich. Red Rockcod	5
Scorpis lineolatus Kner. Sweep	11
Spheroides hamiltoni (Rich.). Common Toado	6
Trachichthodes affinis (Gunth.). Nannygai	2
Trachurus declivus (Jenyns). Yellow-tail	1
Upeneichthys porosus (Cuv. and Val.). Blue-striped Red Mullet	2
Verreo oxycephalus (Bleeker). Pig-Fish	1
Total	142

Parasites have been found in the following:—

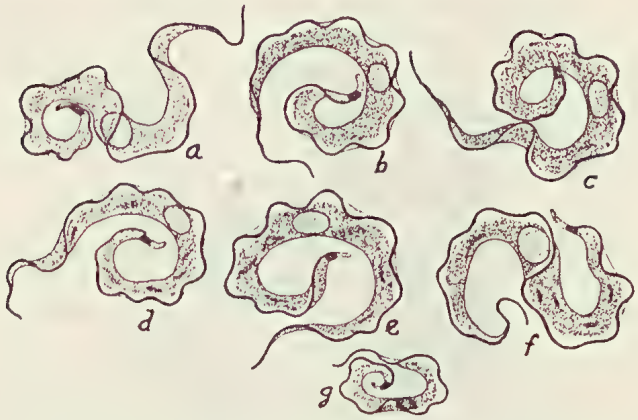
Aulopus purpurissatus Rich. Sergeant Baker. (Fam. Aulopidae, Ord. Iniomi.). 8 examined, Trypanosomes in 1, Haemogregarines in 1.

Gilbertia annulata (Gunth.). Banded Sea Perch. (Fam. Serranidae, Sec. Perciformes, Subord. Percoidea, Ord. Percomorphi.). 3 examined, Haemogregarines in 1.

Gilbertia semicincta (Cuv. and Val.). Half-banded Sea Perch. 38 examined, Trypanosomes in 3, Haemogregarines in 4.

Parma microlepis Gunth. White-ear. (Fam. Pomacentridae, Sec. Pomacentriformes, Subord. Percoidea, Ord. Percomorphi.). 9 examined, Trypanosomes in 1, Trypanoplasms in 3, Haemogregarines in 7.

The total number of individuals infected was 15, or 7.5% of all fish examined.



Text-figure 1. *Trypanosoma pulchra*, n. sp.; *a*, *b* and *c* from *Gilbertia semicincta* (Cuv. and Val.); *d*, *e* and *f* from *Parma microlepis* Gunth.; *g*, small form from *Gilbertia semicincta* (Cuv. and Val.). × 1180.

Haemoflagellates.

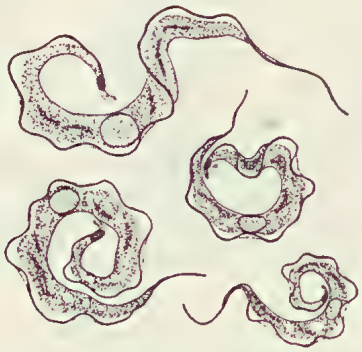
TRYPANOSOMA PULCHRA, n. sp.

Hosts: *Gilbertia semicincta* (Cuv. and Val.) and *Parma microlepis* Gunth. Present in 3 out of 38 of the former and 1 out of 9 of the latter. Sydney and Broken Bay, N.S.W. January, May and June.

An average individual from the type slide is shown in Fig. 1*a* and has the following measurements: Length of body 48.3μ, diameter of body at level of trophonucleus 3.5μ, kinetonucleus is 1.7μ from aflagellar end and measures 1.6μ by 0.8μ, trophonucleus is 22.5μ from aflagellar end and measures 4.0μ by 2.9μ, diameter of undulating membrane 1.0μ to 1.5μ, free part of flagellum 7.3μ. The body length varies from 57.1μ to 40.8μ, but the relative proportions of the parts and the general appearance of the individuals remain constant within fairly narrow limits, except for two small specimens to be described later. The cytoplasm of the body is rather dense and stains a deep blue with Eosin-Azur. It shows irregular lighter and darker areas and a number of small scattered vacuoles. The aflagellar end is beak-shaped and stains a very pale blue. The undulating membrane is clear and takes a pale pink stain. The flagellum appears to arise directly from the deep red kinetonucleus, there being no separate basal granule visible. The trophonucleus stains uniformly pink and shows no sign of a karyosome or of chromatinic granules.

In one infection (*G. semicincta* No. 26), two very small individuals were seen along with the ordinary form (Fig. 1*g*). Their lengths are 27.2μ and 26.5μ and they differ from the common form in that the flagellum is relatively longer, the undulating membrane is relatively wider (being in both cases about the same as in the larger type), and in the condition of the trophonucleus which shows a number of dark granules scattered throughout, but rather more numerous at the ends. What relation these bear to the common type, or whether they are possibly a distinct species, we are at present unable to say. Similarly, we cannot decide positively whether the infections from the two hosts represent one or two species. Though the hosts are not very closely related, they are found together in the same situation on rocky bottoms and the parasites are morphologically indistinguishable. Consequently, we see no valid reason for separating them at present.

Type slide (*G. semicincta* No. 35*g* in our series) in the Australian Museum, Sydney.



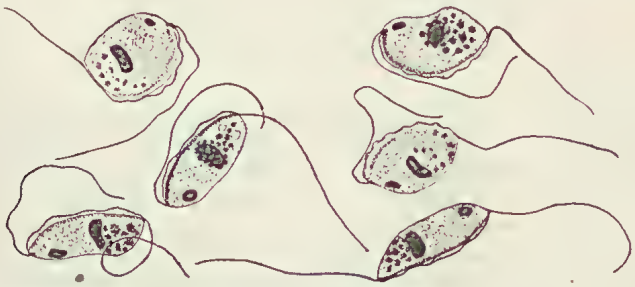
Text-figure 2. *Trypanosoma aulopi*, n. sp. × 1180.

TRYPANOSOMA AULOPI, n. sp.

Host: *Aulopus purpurissatus* Rich. Present in 1 out of 8. Sydney, N.S.W. May.

This species, of which we have but one scanty infection, is separated from *T. pulchra*, nov., because of its very marked pleomorphism. In general body form, proportions, and staining reactions it is similar to the common larger form of *T. pulchra*, nov., but individuals of widely different sizes are encountered with equal frequency. The following are the body lengths (in μ) of nine consecutive individuals arranged in order of size:—57.1, 53.0, 50.3, 47.5, 44.8, 36.3, 33.5, 33.5, 29.1. Nothing was found quite as small as the small specimens from *G. semicincta*. The host belongs to the Iniomi, an order widely separated from the Percomorphi, to which the hosts of *T. pulchra*, nov., belong. It is, however, also a rock fish living in a not very different habitat and there are definite possibilities of cross infection occurring. Taking everything into consideration, and having in mind the usual practice amongst haematozoologists, it seems most reasonable in the present state of our knowledge to propose a separate name for this species, leaving it for future work with much more extensive series from all three hosts to decide the identity or otherwise of the various forms.

Type slide (*A. purpurissatus* No. 1 of our series) in the Australian Museum, Sydney.



Text-figure 3. *Trypanoplasma parmae*, n. sp. × 1180.

TRYPANOPLASMA PARMAE, n. sp.

Host: *Parma microlepis* Gunth. Present in 3 out of 9. Sydney, N.S.W. November.

Owing to the soft and mobile nature of the body most of the parasites become somewhat distorted in dried films and the following description is based on those specimens which had obviously retained their natural shape more or less completely. This species is monomorphic and of a somewhat broad type, varying from 12.5μ long by 3.8μ wide to 14.7μ long by 5.0μ wide. The cytoplasm stains a faint blue and is finely and irregularly granular. Anteriorly it is pale and indistinctly vacuolated, whilst behind the trophonucleus it is denser and contains numerous round or irregular chromatoid bodies, 0.25μ to 1.25μ or occasionally more in diameter; these sometimes extend round the anterior margin of the trophonucleus. Along the full length of the dorsal edge of the body, and marking the origin of the undulating membrane, is a narrow zone of densely packed fine granules which stain a reddish colour with Eosin-Azur.

The trophonucleus, which is situated behind the middle of the body, is reniform or occasionally oval in shape, measures 3.7μ to 3.0μ by 1.5μ to 2.3μ and is fairly densely packed with large irregular chromatinic masses. The kinetonucleus is a large oblong or oval mass, from 1.7μ to 2.0μ long by 1.0μ to 1.3μ wide, and is situated close to the ventral surface about 2μ from the anterior end of the body; it stains an intense reddish-black and rarely gives any indication of internal organization. The blepharoplast is a minute darkly stained granule, which usually appears single but is occasionally clearly double; it lies close to the anterior extremity of the body. No definite rhizoplast could be made out in our preparations. The anterior free flagellum measures from 18.0μ to 25.0μ in length. The posterior flagellum is attached to the body by a very narrow undulating membrane which is little more than 0.25μ wide; its free terminal part measures 18.0μ to 26.8μ.

Many of the specimens in our slides were rounded and some showed irregular bulgings as if about to burst. Such distorted examples are from 9.5μ to 11.1μ long by 6.9μ to 8.5μ wide, the measurements of other parts being similar to those given above. In one or two specimens a number of clear unstained vacuoles, 1μ to 2μ in diameter, were seen; these had very sharply marked outlines and gave the impression of being signs of impending dissolution rather than of any normal process.

The special interest attaching to this parasite is that, while *Trypanoplasma* (or *Cryptobia*) has long been known as a parasite of invertebrates, of the alimentary tract of frogs and marine fish, and of the blood of freshwater fish, this is, so far as we are aware, the first record of its occurrence in the blood of a marine fish.

Type slide (*P. microlepis* No. 4*d* of our series) in the Australian Museum, Sydney.

Haemogregarines.

HAEMOGREGARINA AULOPI, n. sp.

Hosts: *Aulopus purpurissatus* Rich. and ? *Parma microlepis* Gunth. Present in 1 out of 7 of the former and ? 2 out of 9 of the latter. Sydney, N.S.W. May.

This parasite was present in the same slide as *Trypanosoma aulopi*, nov., and was not nearly so scanty. It is small and is not so uniform in shape as is the case with most Haemogregarines. In certain respects it resembles the little known genus *Pirhaemocyton* Chatton et Blanc, which is parasitic in Geckos.

Three distinct types of parasite are present in this infection, large oval forms, small rounded forms and slender forms. The large oval forms (Fig. 4*a*) are least common, measure 4.5μ by 2.9μ, and occur singly. The outline is definite

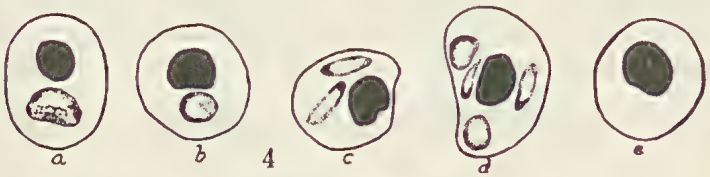
and the cytoplasm clear, except for a peripheral zone which is denser and stains blue; sometimes delicate branching strands of denser blue cytoplasm invade the clear central area. The chromatin is collected for the most part in blocks at the periphery, but strands of linked granules extend in many cases into the central area.

The rounded forms (Fig. 4, *b* and *d*) most frequently occur two in a cell, but single infections are often met with, and once four were seen in one cell. The size seems to bear some relation to the number present in the cell, single infections measuring about 3.3μ by 2.5μ, double infections are slightly smaller, not more than 3.0μ long, usually less, while in the quadruple infection the parasites measured 2.3μ by 1.8μ. The cytoplasm is similar to the larger form, but the chromatin is more densely aggregated into peripheral blocks or bands; one specimen was intermediate between the two forms in size and chromatinic arrangement. It seems likely that the smaller forms are the products of division of the larger, fission being into two, and these may divide again, giving rise to the four very small parasites described above.

The slender form (Fig. 4, *c* and *d*) always occurred in pairs. In one case a pair of the slender form and a pair of the rounded form occupied the same cell (*d*). They were fairly uniform in size, measuring on an average 4.7μ by 1.5μ. Their outline is always more delicate than in the other forms and the chromatin is collected into a block at one end with an occasional granule at the periphery further along the body. Nothing was seen linking these with the other forms, and what stage they represent we cannot say at present, though they may be the gametocytes.

In *Parma microlepis* No. 6*a*, a single cell was found containing four parasites rather closely resembling those shown in Fig. 4*d*, and in *Parma microlepis* No. 7*a*, one cell was also seen containing two short rather shrunken parasites. These are quite possibly *H. aulopi*, nov., but, as no other parasites of this type were found in all our material from *Parma microlepis*, one cannot be sure of the identification.

Type slide (*A. purpurissatus* No. 1 of our series) in the Australian Museum, Sydney.



Text-figure 4. *Haemogregarina aulopi*, n. sp. *a*, *b*, *c* and *d*, different types of infections; *e*, normal host cell. × 1400.
Text-figure 5. *Haemogregarina gilbertiae*, n. sp. *a*, *b* and *c*, intracellular forms; *d* and *e*, vermicules; *f*, normal host cell. × 1400.

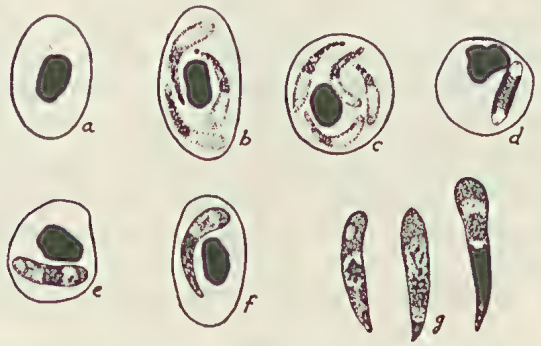
HAEMOGREGARINA GILBERTIAE, n. sp.

Hosts: *Gilbertia semicincta* (Cuv. and Val.) and *Gilbertia annulata* (Gunth.). Present in 4 out of 38 of the former and 1 out of 3 of the latter. Sydney and Broken Bay, N.S.W. January and November.

This species is larger and more uniform in shape than *H. aulopi*, nov. It is usually single, but double infections frequently occur, and once three parasites were found in one cell (Fig. 5*c*). The shape is broadly oval and the size is in general very uniform, being about 4.2μ by 2.5μ. Smaller or larger forms are rare; the smallest individual seen measured 3.5μ by 2.0μ, while a few longer, somewhat slenderer individuals were found which measured up to 5.6μ by 2.2μ. The parasites in single infections were slightly larger than those in double infections in which the members of a pair were almost always of exactly the same size. The cytoplasm is clear and only stains at the periphery. The chromatin is arranged in a loose skein towards one end of the parasite and is sometimes more concentrated in blocks at the sides (Fig. 5*b*); occasionally it is widely spread out in the form of scattered granules.

Two free parasites were seen, the first (Fig. 5*d*) apparently being an early stage in the development of a free vermicule. It measures 4.3μ by 3.4μ and consists of two parts separated by a band of chromatinic granules. The larger part resembles the ordinary intracellular parasite, while the smaller tapering part stains like the fully developed vermicule. This second form (Fig. 5*e*) measures 10.4μ by 1.9μ; its outline is delicate and the cytoplasm stains a pale greyish-blue; the chromatin is collected into two masses of granules towards one end. Both ends are rounded and the body has not the streamline form usual amongst vermicules as exemplified by the parasites shown in Fig. 6*g*. The intracellular parasites could not be differentiated into gametocytes and schizonts.

Type slide (*G. semicincta* No. 27*d* of our series) in the Australian Museum, Sydney.



Text-figure 6. *Haemogregarina parmae*, n. sp. *a*, normal host cell; *b*, *c* and *d*, schizonts; *e* and *f*, intracellular gametocytes; *g*, free gametocytes. × 1400.

HAEMOGREGARINA PARMAE, n. sp.

Host: *Parma microlepis* Gunth. Present in 7 out of 9 examined. Sydney, N.S.W. November and June.

The more numerous and more abundant infections available have enabled us to study this species in greater detail than was possible in the case of the other

species described above. Two distinct stages are present in our preparations; they can be allotted with little doubt to the schizogenous and gametogenous generations respectively.

The schizonts occur most frequently three or four in a cell; occasionally single or double infections are to be met with, and very rarely as many as six or seven parasites occupy a single cell, these being probably the result of a double initial infection. Since our infections are never so abundant as to make it probable that double infections are more than a very occasional occurrence, the presumption is that the three or four parasites usually found have originated from a single initial infection. There is usually definite enlargement of the infected cell, the amount of enlargement and the size of the contained parasites probably being an indication of the duration of the infection of that cell. The individual parasites (Fig. 6, *b* and *c*) vary from 6.2μ to 9.6μ long, about 8μ being the commonest, by from 1.2μ to 1.7μ wide. The body is delicate in outline, tapering more towards one end than the other and is usually somewhat curved. The cytoplasm stains a delicate blue, paler towards the centre which, occasionally, has the appearance of a definite oval vacuole. The chromatinic material is aggregated towards the middle with strands and granules extending into the more attenuated end of the body.

The gametocytes are more definite in outline and stouter bodied than the schizonts. When contained within a cell (Fig. 6*e*) both ends are usually rounded, but in forms about to leave the cell (*f*), and in free forms (*g*) the posterior end tapers to a point, while the anterior end is broadly rounded; several transition stages between the type shown in (*e*) and those shown in (*g*) are to be seen in our slides. The intracellular gametocytes averaged 7.1μ by 1.9μ, and the free vermicules varied according to their development, the largest being 13.4μ by 2.9μ and the usual size 11.5μ by 2.3μ. The cytoplasm stains much darker than is the case with the schizonts, and always has a pinkish tint which they never show; it is somewhat blotchy in appearance and the anterior end is always darkly stained. The chromatin may extend throughout the posterior half of the body or be collected into a mass of blocks and granules near the middle. It is not possible to differentiate between male and female gametocytes in our material, nor was there any indication of the occurrence of a process of maturation. The gametocytes must leave the cells very rapidly on the blood being drawn, because a considerable number of free forms were seen, which is remarkable in view of the haste with which smears were made. Of course, they may exist free in the blood, but this is not the case with other species of Haemogregarine which we have been able to observe in the living state. The proportion of schizonts to gametocytes varies in the different infections, those showing the most gametocytes being probably the oldest.

Type slide (*P. microlepis* No. 9*c* of our series) in the Australian Museum, Sydney.

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THE GASTEROMYCETES OF AUSTRALASIA.

iii. The Genera Bovista and Bovistella.

By G. H. Cunningham, Mycologist, Dept. of Agriculture, Wellington, N.Z.

(Plate xxxvii.)

[Read 30th September, 1925.]

Both *Bovista* and *Bovistella* are included in the family Lycoperdaceae. Although species of each genus are not numerous, they are fairly widely distributed, save the Australasian species which, with one exception, are limited to this biologic region.

The name *Bovista* was first used by Dillenius (1719) and later in a generic sense by Persoon (1801); but it was not until the appearance of Morgan's paper (1892) that members of the genus came to be recognized in their present sense. Prior to this the name appears to have been loosely applied to any lycoperdaceous plant without a sterile base, as reference to the Gasteromycetes in Saccardo's *Sylloge Fungorum* (1888) will show, for herein are included under *Bovista* members of the genera *Lycoperdon*, *Bovista*, *Bovistella*, *Catastoma* and *Calvatia*. Cooke (1892) likewise appears to have had but a vague idea as to what should be included in *Bovista* for, according to Lloyd (1905), of the seven Bovistas included in this work, five are Catastomas and one is a *Calvatia*. On account of the habit of members of the genus, Lloyd (1902, *a*) places it in the tribe Bovisteae, or "tumblers."

Bovistella was erected by Morgan (1892) as a monotypic genus. His conception of the genus was one possessing the capillitium of *Bovista* with, in addition, a sterile base. In his earlier papers Lloyd (1902, *a*, *b*) claimed that the presence of a sterile base was not a good character on which to separate these two genera (basing his argument on the fact that it has not been considered of sufficient moment to separate *Globaria* from *Lycoperdon*) and proposed to separate the two upon habit, *Bovista* being a genus in which plants break away at maturity from the point of attachment, *Bovistella* persisting as does *Lycoperdon*. The writer would follow Lloyd's emendation in so far as the habit is concerned, for it is the only character upon which separation is possible.

In a later paper Lloyd (1905) further emends *Bovistella* to include all plants possessing a rooting base together with either pedicellate spores or capillitium of the *Bovista* type or both. Thus many species included in *Lycoperdon* (possessing the capillitium of *Lycoperdon*) are by Lloyd placed in *Bovistella*. He claims (1906, *a*) it would simplify matters to take from the genus *Lycoperdon* (which is a large and unwieldy genus) a natural section and place it in another genus with which the section agrees in a prominent character and in which it differs from the remainder of the genus *Lycoperdon*. The writer cannot agree with Lloyd in this grouping, for capillitium characters are of greater importance than spore characters, especially when they are so well defined as in the different genera of

the Lycoperdaceae. It would simplify matters to erect a section under *Lycoperdon* for those species possessing pedicellate spores, and thus save the confusion that would otherwise be caused.

Structure of the Mature Plant.

A mature plant consists of two groups of tissues, (*a*) peridium, (*b*) gleba.

(*a*) *Peridium.*—This is invariably globose, elliptical or depressed-globose and consists of two distinct tissues, (1) the exoperidium, (2) the endoperidium. The exoperidium in the mature plant usually falls away, leaving the endoperidium exposed, or may be partially persistent as in *Bovista purpurea*, here appearing in the nature of a much broken, thin and fragile outer covering (Plate xxxvii, fig. 2). It consists either of loosely interwoven non-gelatinized hyphae, or else pseudo-parenchymatous tissue. Frequently it persists on the endoperidium as minute scales or blunt points, giving to this structure a roughened appearance.

The endoperidium is in the nature of a very thin, papyraceous membrane enclosing the gleba and perforated by a single apical orifice; it varies in colour from bay-brown to purple, the colour being fairly constant with the species. Microscopic examination shows the endoperidium to consist of intricately interwoven, gelatinized hyphae and in addition (in *Bovista brunnea*) are present numerous ramifying hyphae, several times the diameter of the normal hyphae, thick-walled and filled with coarse granular matter. The apical orifice (mouth) through which the spores escape at maturity is usually circular or elliptical in outline and may be plane or surrounded by a slightly elevated, toothed margin.

(*b*) *Gleba.*—The whole of the tissue enclosed within the endoperidium is termed the gleba. At maturity it consists of a mass of short branched capillitium threads immixed with very numerous spores. Each thread is of a peculiar structure, consisting of a thick stout stem from which arise numerous dichotomously branched acuminate lateral branches (Plate xxxvii, fig. 1). These structures are characteristic of the genera *Bovista* and *Bovistella*. The wall of the thread varies in thickness and colour and is usually perforated with numerous pits or depressions, which penetrate to the lumen. Their function is unknown. The threads vary according to the species in the degree of branching, thickness of the wall of the main stem, length of the branches and presence or absence of pits. In all the species examined no septa are present. In the mature plant these threads appear aggregated into small balls, giving to the ripe gleba a granular appearance.

The spores are obovate or globose, thick-walled, 5-6μ in diameter, and possess either a rough or a smooth epispore. All are some shade of brown. To each is attached the sterigma (absent in *Bovistella pusilla*) an appendage which is hyaline, varies in length from 10 to 25μ, and is usually acuminate.

Dehiscence of the spores is effected through the mouth, but the exact manner of emergence is unknown. The capillitium threads are slightly hygroscopic and possibly owing to this and to the expansion and contraction of the endoperidium brought about by changes in atmospheric humidity or temperature, spores are forced through the opening and dispersed by the wind. In *Bovista* plants break away at maturity from the point of attachment and are rolled over the ground by the wind, often for considerable distances. Doubtless numerous spores are forced out through repeated blows upon the endoperidium during the rotation of the plants when being carried along in this manner. As *Bovistella* remains attached to the substratum at maturity, this probable method of spore discharge

cannot occur. The development of one of the species of the genus *Bovista* is being published elsewhere.

Artificial Key to the Genera.

Plants breaking away from the point of attachment at maturity ..... *Bovista*
Plants remaining attached to place of origin, not breaking away at maturity ..... *Bovistella*

BOVISTA Dillenius *ex* Persoon.
Syn. Meth. Fung., 1801, p. 136.

Plants breaking away from the point of attachment at maturity.

Peridium globose, subglobose or shortly pyriform; consisting of an outer, usually fugacious exoperidium, and a membraneous, tough, firm endoperidium, which dehisces by an apical, definite or indefinite mouth.

Gleba without a sterile base; capillitium of free threads, each consisting of a thick stem and dichotomous, tapering, acuminate branches.

Spores coloured, continuous, rough or smooth, globose, obovate or elliptical, pedicellate or apedicellate; basidia tetrasporous.

Habitat.—Solitary on the ground.

Distribution.—Europe; North and South America; Australia; New Zealand.

Two species only are known in Australia and/or New Zealand, both being confined to this biologic area.

1. BOVISTA BRUNNEA Berkeley.
Flora N.Z., vol. 2, 1855, p. 119.

Peridium depressed-globose, up to 2.5 cm. diam., with a minute rooting base which usually falls away at maturity; exoperidium white, evanescent; endoperidium chestnut-brown or pallid umber-brown, firm, smooth, shining. Mouth up to 2 mm. diam., irregularly circular or indefinite and irregularly torn, slightly erumpent, toothed or entire, frequently almost plane.

Gleba pallid ferruginous-brown; capillitium of the usual type but more scantily branched, walls thin and pitted. Spores globose or obovate, 4-6μ, pedicel tinted or hyaline, acuminate, 10-13μ long; epispore pallid-ferruginous, closely and finely verruculose, 1.5μ thick.

Habitat.—Solitary on the ground.

Distribution.—Australia; New Zealand: Shore of Lake Te Anau, Otago, Jan., 1920 (E. H. Atkinson), Methven, Canterbury, Feb., 1925, Immature (J. C. Neill).

This species is characterized by the firm, dark-brown, smooth and shining endoperidium, stout, sparingly branched, thin-walled capillitium, and pallid, distinctly verruculose spores.

Two collections from Lake Te Anau were forwarded to Lloyd for determination (Nos. 73, 572). He determined one as *Bovista brunnea*, the other as *Bovistella bovistoides*. The writer has since ascertained that both collections consisted of these two species.

Lloyd (1906, *b*) believes this species to be an old weathered form of *Bovista tomentosa* Vitt., for he finds, in certain Australian collections, the immature specimens possess a finely spinous exoperidium. As there is no indication in Vittadini's work that he described immature plants, the writer fails to see where the connection between the two lies, for this reasoning may equally well be applied to *Bovistella bovistoides*, as the immature plants of this species also possess a finely tomentose exoperidium.

The type was collected by Colenso on the banks of the Manawatu River, Wellington, N.Z., and is now preserved in the Kew Herbarium. The writer has seen no specimens of this species from Australia.

2. Bovista purpurea Lloyd.

Mycological Notes, 1923, p. 1201, Figs. 1, 2, 5, 9.

Peridium globose or depressed-globose, up to 2.5 cm. diam., with a small pulvinate rooting base; exoperidium thin, dingy-white or brown, evanescent, falling away in irregular flakes or scales, but partly persisting towards base; endoperidium usually lead-coloured, often purplish, smooth, firm, shining, dehiscing by an apical, irregularly torn, circular or elliptical mouth, which is erumpent, irregularly toothed and up to 5 mm. diam.

Gleba purple-brown; capillitium of the usual type, but stout, freely branched and not pitted. Spores obovate or globose, 5-6μ diam., pedicels hyaline, acuminate, up to 12μ long; epispore chestnut-brown, verruculose, 1μ thick.

Habitat.—Solitary on the ground.

Distribution.—New Zealand: Mapua, Nelson, May, 1922 (G.H.C.; Type coll., Lloyd No. 700), Ashburton, Canterbury, Jan., 1925 (J. C. Neill), Blenheim, Marlborough, May, 1925 (J. C. Neill).

This species is characterized by the dark colour, flaking endoperidium, distinctly verruculose spores and stout, strongly branched, non-pitted capillitium.

Excluded Species.

Of the seven species recorded in Cooke's Handbook (1892) one, *B. brunnea*, is valid; *B. Muelleri*, *B. hyalothrix*, *B. hypogea*, *B. anomala* and *B. cervina* should be placed in *Catastoma*, and *B. olivacea* in *Calvatia*.

Bovistella Morgan.

Journ. Cincinnati Soc. Nat. Hist., vol. 14, 1892, p. 145.

Plants remaining attached to place of origin, not breaking away at maturity; with a well developed rooting base.

Peridium globose or pyriform, of two layers; an external, thin, usually fugacious exoperidium, and an inner thin, flaccid, membraneous endoperidium which dehisces by an apical definite or indefinite mouth.

Gleba with or without a well defined sterile base; capillitium of free threads, each consisting of a thick stem and dichotomous, tapering, acuminate branches. Spores coloured, continuous, rough or smooth, globose, obovate or elliptical, pedicellate or apedicellate.

Habitat.—Solitary on the ground.

Distribution.—Europe; North America; India; Australia; New Zealand.

Artificial Key to Species.

Spores pedicellate—
- Peridium pallid-tan, finely tomentose ..... 1. *B. verrucosa.*
- Peridium dark brown, areolate ..... 2. *B. bovistoides.*

Spores apedicellate ..... 3. *B. pusilla.*

1. Bovistella verrucosa, n. sp. Plate xxxvii, figs. 3, 7.

Peridium globose or shortly pyriform, up to 15 mm. diam.; with a strong, well-marked rooting base; exoperidium in the nature of a very delicate layer, soon more or less completely flaking away; endoperidium dingy-white or pallid-tan, minutely and delicately tomentose, appearing almost smooth, very thin and fragile, flaccid, opening by an apical, irregular, indefinite plane mouth.

Gleba bay-brown, sterile base absent; capillitium threads of the usual type, pitted. Spores globose, 4-6μ, pedicels hyaline, acuminate, up to 12μ long; epispore tinted, finely and closely verrucose, 1.5μ thick.

Habitat.—Solitary on the ground.

Distribution.—South Australia: Monarto South, Sept., 1922, J. B. Cleland. Type, in Herb. Cleland.

The small size, pallid colour and tomentose nature of the endoperidium and rough pallid spores characterize this species.

2. Bovistella bovistoides (Cooke and Massee) Lloyd. Plate xxxvii, figs. 4, 6, 8.

Myc. Notes, 1906, p. 247.—*Mycenastrum bovistoides* Cke. et Mass., *Grev.*, vol. 16, 1888, p. 26.—*Scleroderma bovistoides* (Cke. et Mass.) De Toni, in Sacc. *Syll. Fung.*, vol. 7, 1888, p. 489.

Peridium globose, depressed-globose or shortly pyriform, up to 2 cm. diam., with a strong rooting base which frequently attains a length of 1.5 cm.; exoperidium thin, white, persisting as small areolate areas over the upper part of the endoperidium, but scanty or absent from lower, frequently falling away completely when the endoperidium appears marked with lines arranged in an areolate manner; endoperidium flaccid, dull bay- or chestnut-brown, darker basally; mouth apical, usually elliptical, frequently indefinite, slightly erumpent and toothed, sometimes almost plane.

Gleba olivaceous, becoming umber, sterile base absent; capillitium of the usual type, threads much branched, thick-walled, pitted, dark chestnut. Spores globose, seldom obovate, 4-6μ diam., pedicels tinted, attenuate, up to 15μ long; epispore chestnut-brown, minutely and delicately verruculose, almost smooth, 1μ thick.

Habitat.—Solitary on the ground.

Distribution.—India; Australia; New Zealand. South Australia: Flinders Range, near Pt. Augusta, Aug., 1922 (J.B.C.), Mr. Zeitz coll. (Herb. Clel.); New South Wales: Wagga, July, 1914 (J.B.C.); New Zealand: Banks's Peninsula, Dunedin, Otago, July, 1922 (Miss H. K. Dalrymple), Tapanui, Otago, March, 1922 (G.H.C.).

Different collections of this species vary in the size and extent of the areolate markings. As it is impossible from the material at hand to separate any one collection from another, it is thought advisable to keep all together. The colour of the peridium varies much according to the age of the plant, so that it cannot be used as a specific character.

The rooting base separates this from *Bovista brunnea*, which otherwise it resembles closely. As this structure may frequently be absent from old weathered specimens, and as the areolate markings also disappear, it is extremely difficult to place old specimens of either species. The spore markings and capillitium in such cases serve as the only characters by which separation can be made, for the spores of *Bovista brunnea* are more coarsely verruculose than those of *Bovistella bovistoides*, and the capillitium is more scantily branched, more pallid in colour and the walls are thinner.

The collection made at Tapanui is so well marked, and has such a small rooting base that the writer was at first inclined to separate it and place it under the genus *Bovista*, but critical examination of the capillitium and spores shows it to be but a strongly marked form of *Bovistella bovistoides* with a weak development of the rooting base.

The species is characterized by the areolate markings and dark colour of the endoperidium, chestnut, verruculose spores and stout, strongly branched, thick-walled, pitted capillitium.

3. Bovistella pusilla Lloyd.

Mycological Notes, 1910, p. 457.

"Plant globose, 1-1.5 cm. diam.; cortex smooth, peridium thin, flaccid, sterile base none; gleba dark brown; capillitium deeply coloured, with numerous tapering branches. Spores compressed-globose or slightly ovoid, 4 × 4μ; deeply coloured, smooth, with short but distinct apiculus.

Brisbane, E. Jarvis".

The writer has not seen specimens. The description given is that of the original. The species is characterized by the apedicellate spores.

Excluded Species.

(*a*) *Bovistella aspera* (Lev.) Lloyd, *Lyc. Aus.*, 1905, p. 28 = *Lycoperdon asperum* (Lev.) De Toni, in Sacc. *Syll. Fung.*, vol. 7, 1888, p. 119.

(*b*) *Bovistella australiana* Lloyd, *Lyc. Aus.*, 1905, p. 28.

(*c*) *Bovistella cuprica* Lloyd, *Letter No. 60*, 1915, p. 9. This the writer believes to be a *Lycoperdon*, but the description is so poor as to make the placing in any genus uncertain.

(*d*) *Bovistella glabrescens* (Berk.) Lloyd, *Lyc. Aus.* 1905, p. 28 = *Lycoperdon glabrescens* Berk., *Fl. Tas.*, vol. 2, 1860, p. 264.

(*e*) *Bovistella Gunnii* (Berk.) Lloyd, *Lyc. Aus.*, 1905, p. 29 = *Lycoperdon Gunnii* Berk., *Fl. Tas.*, vol. 2, 1860, p. 265.

(*f*) *Bovistella rosea* Lloyd, *Myc. Notes*, 1906, p. 248.

(*g*) *Bovistella nigrica* Lloyd, *Myc. Notes*, 1922, p. 1115.

All are excluded from *Bovistella* as they possess the typical *Lycoperdon* capillitium. They will be dealt with under the genus *Lycoperdon* in a subsequent paper.

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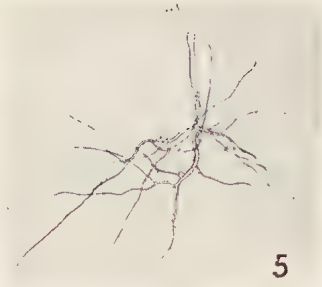
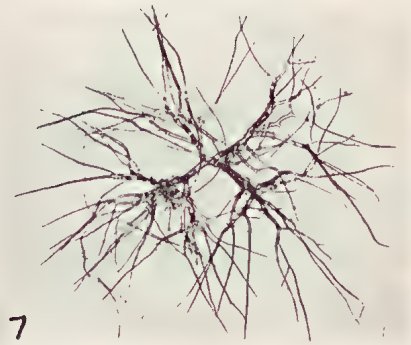
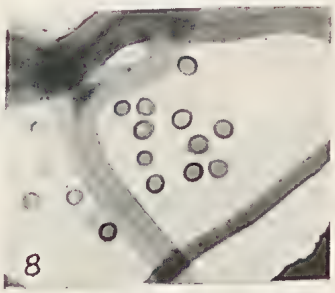
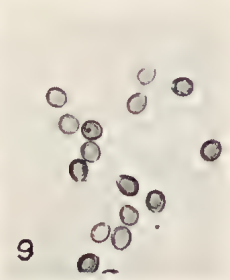
EXPLANATION OF PLATE XXXVII.

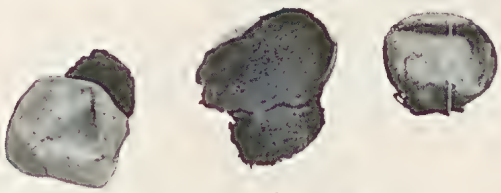
1. Capillitium of *Bovista purpurea* Lloyd. × 110. This shows the main stem and dichotomous, tapering branches.
2. *Bovista purpurea* Lloyd. × ⅔. The specimen in the centre shows the partly adhering exoperidium.
3. *Bovistella verrucosa* G. H. Cunn. Natural size. Note the roughened surface of the endoperidium.

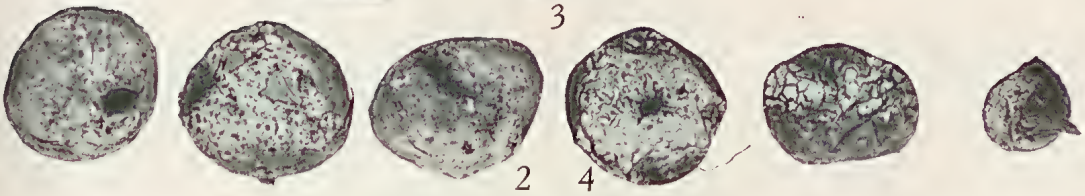












Gasteromycetes of Australasia.
1, 2, 5, 9. *Bovista.* 3, 4, 6, 7, 8. *Bovistella.*

4. *Bovistella bovistoides* (Cke. et Mass.) Lloyd. × ⅔. These specimens (from Tapanui) show unusual development of areolate markings.
5. Capillitium of *Bovista purpurea.* × 55.
6. Capillitium of *Bovistella bovistoides.* × 55.
7. Capillitium of *Bovistella verrucosa.* × 55. The opaque areas in the lumen are air bubbles.
8. Spores of *Bovistella bovistoides.* × 540. The hyaline pedicels are scarcely discernible. Note the thick-walled capillitium.
9. Spores of *Bovista purpurea.* × 540.

The photographs of the mature plants were taken by Mr. H. Drake, of this laboratory. The photomicrographs were taken by the writer, but the plates were developed and printed by Mr. Drake, to whom the writer's thanks are due.

A NEW FOSSIL INSECT WING FROM TRIASSIC BEDS NEAR DEEWHY, N.S.W.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.R.S., F.N.Z. Inst., F.L.S., F.G.S., F.E.S., C.M.Z.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Plate xxxvi and one Text-figure.)

[Read 30th September, 1925.]

Through the kindness of Professor Sir T. W. E. David, F.R.S., Emeritus Professor of Geology in the University of Sydney, I have been enabled to study a remarkable new insect wing which has recently been discovered in a magnificent state of preservation in a quarry at Beacon Hill, near Deewhy (not far from Manly), N.S.W. The bed from which this wing comes is a shale bed, about the middle of the Hawkesbury Sandstone (Middle Triassic), *i.e.*, about 500 feet above the base of this sandstone; thus it will be seen that the wing is older than those found at Ipswich, Queensland, and at St. Peter's, Sydney.

Professor David writes as follows concerning the discovery of this fossil: "There was more of the fossil when the quarrymen broke open the shale, but unfortunately Mr. Scully (a most careful and enthusiastic collector, one of the quarrymen) accidentally broke it in trying to get it out, and the body flew into a thousand fragments. We must be thankful, however, for the beautiful wing. But for Mr. Scully it would have been pressed into bricks, probably in a few minutes' time."

Before describing this fossil, which consists, unfortunately, only of about the distal two-thirds of an enormous wing, I would like to say what a great loss has been sustained just by the failure to retrieve the rest of the specimen. This fossil belongs to the rarest and least known of all orders of fossil insects, and it is so wonderfully preserved that its head and body, particularly if, as I suspect, the mouth-parts were displayed *in situ*, would have afforded one of the most wonderful discoveries ever made in fossil Insecta. It is greatly to be hoped that some way may be found to get all the quarrymen in the Triassic shale-beds around Sydney interested in these wonderful fossils, a large number of which have probably gone already into the making of bricks for Sydney suburban houses.

In 1916, when I first started studying fossil insects, I described as *Mesotitan giganteus* Till.* a very large but badly preserved fossil insect from the Wianamatta Shale (Upper Triassic) of St. Peter's, Sydney, placing it in the Order Protorthoptera. The condition of this fossil was not such as to allow of any accurate placing or diagnosis of it, but considerable portions of three wings were preserved, showing the main courses of the basal parts of the veins, and also the remarkable

* "Mesozoic and Tertiary Insects of Queensland and N.S.W." Queensland Geol. Survey, Publ. No. 253, 1916, p. 40, Pl. 7, fig. 2.

archedictyon or meshwork of fine veinlets and crossveins between them. A considerable part of the body was indistinctly visible; but, most unfortunately, a large triangular crack in the rock had removed the head entirely. Having given this fossil some further study from time to time, I have become more and more inclined to the view that it is not a member of the Order Protorthoptera at all, but belongs to the very rare and problematical Order Protohemiptera, founded by Handlirsch for the wonderful Lower Permian fossil *Eugereon boeckingi* Dohrn from Germany. This insect was of large size (Handlirsch's estimate of its expanse of wing is 160 mm., or over six inches). Its most remarkable characteristics are the broadly flanged pronotum, resembling that of certain Carboniferous forms, and the very small head provided with mouth-parts forming a very long and slender sucking-beak, which projects straight out in front of the head. Probably no type of mouth-parts has given rise to more discussion than this, and its relationships, if any, to the mouth-parts of recent Hemiptera are still not satisfactorily determined. Hence the discovery of the head and mouth-parts of a related fossil form, in the wonderful state of preservation of this new fossil, would be a find of the utmost importance, and it is to be hoped that it will one day be made.

The head and mouth-parts of the new fossil not being available, one has to fall back on what is left of the wing for evidence of its relationships. The parts preserved are just those, viz. the distal two-thirds of the wing, which are absent from *Eugereon* and also to a great extent from *Mesotitan giganteus*. Nevertheless the general scheme of venation agrees well enough in all three cases, and the strongly-marked character of the archedictyon, in conjunction with the immense size (no other fossils approaching these except only the gigantic Meganeuridae, which are of a very different type), make it certain to my mind that the new fossil must be placed in the genus *Mesotitan*, and that that genus must now find its proper place within the Order Protohemiptera.

Order Protohemiptera.

Restricting our study of this Order to venation, we may state that the following combination of characters will define it:—

Apart from the anals, there are only two convex veins in the wing, viz. R_1 and Cu_1, and both of these are unbranched; no anterior median (MA) or interpolated convex sectors are present. (This character enables us at once to distinguish this Order from Protodonata). Cu_2, which in nearly all Orders is a simple vein, is strongly developed, with many branches; this is a striking and most unusual character. A complete set of costal veinlets is present, arising from the well-developed Sc. Throughout the rest of the wing, between all the main veins and their branches, the membrane of the wing is covered with a very characteristic archedictyon, consisting for the most part of very closely set, transverse, delicate crossveins, the distance between two such consecutive crossveins being very small compared with their length; in the wider spaces, and towards the margin of the wing, these tend to become interrupted by a weak and irregular line dividing them into upper and lower sets, or even to become split up into very irregular polygonal areas. This archedictyon is so characteristic that I am not able to name a single wing outside of this Order which possesses it, and I think a careful study of Plate xxxvi will convince anybody that it must be regarded as one of the diagnostic characters of the Order.

Using venational characters only, the two families represented in this Order may be defined as follows:—

Costal veinlets excessively numerous and close, either transverse or slanting towards the base; Cu_2 only reaching to about half-way along wing ..... Fam. Eugereonidae Handl.

Costal veinlets moderately numerous, not so close together, slanting very obliquely towards apex; Cu_2 ending up far beyond half-way .... Fam. Mesotitanidae, fam. nov.

The Eugereonidae are only known from the Lower Permian of Germany, the Mesotitanidae from the Triassic of Australia.

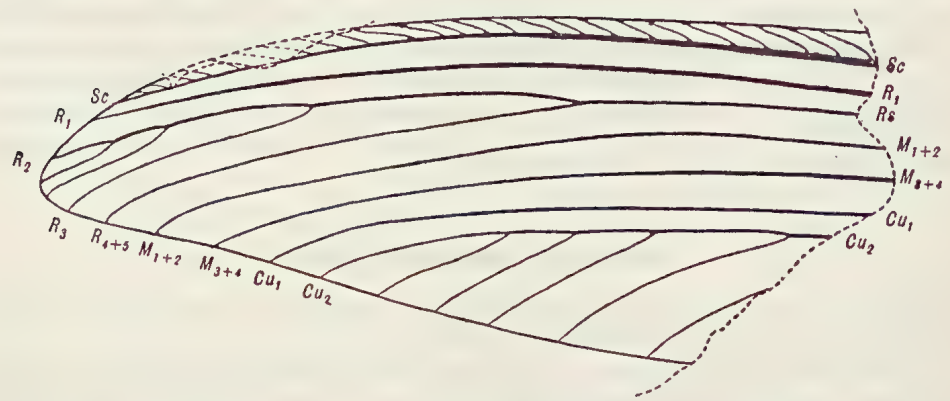
Family Mesotitanidae, nov.

This family is here proposed for the reception of *Mesotitan giganteus* Till. from the Upper Triassic of St. Peter's, Sydney, and the new species described below. Its characters have already been defined in the Key given above.

Genus Mesotitan Till.

Characters as for the family; in addition, Rs pectinate, four-branched, M two-branched, Cu_2 with pectinate series of descending branches.

Genotype, *Mesotitan giganteus* Till.



Text-fig. 1.—*Mesotitan scullyi*, n. sp., preserved portion of forewing from Beacon Hill, near Deewhy, N.S.W. Order Protohemiptera, fam. Mesotitanidae. Length 86.5 mm. Archedictyon omitted.

Mesotitan scullyi, n. sp. Plate xxxvi; text-fig. 1.

Total length of wing preserved, 86.5 mm., indicating a full wing-length of at least 130 mm. and an expanse of wing of 275 mm. or about 11 inches. Greatest width (at break), 34.5 mm.

Apex of wing strongly pointed, slightly nodding. The preserved part of the wing consists of about the distal two-thirds, and does not include the origin of Rs or the forkings of M and Cu, nor is any of the anal area present.

Sc markedly concave, very strongly developed, with slender but clearly marked costal veinlets arising along its whole length; end of Sc about 12 mm. before apex. R_1 markedly convex, but not quite as stout as Sc, running below and subparallel to it and ending just beyond it above apex. Rs a slender, concave vein, unbranched

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Photo. W. C. Davies.

Mesotitan scullyi, n. sp. Forewing, 86.5 mm. long.

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until well past half-way along wing, when it gives off an obliquely descending pectinate series of four veins, the first being R_{4+5}, the second R_3, and the third and fourth two short terminal branches from R_2, the last of which ends at the actual apex of the wing. M with two branches only, M_{1+2} and M_{3+4}, running subparallel to one another and also to Rs and R_{4+5} above and Cu_1 below. Both these branches being concave, there is clearly no MA present. Cu_1 not very strongly developed, but markedly convex, running subparallel to and a little above the well-developed, concave Cu_2, from which a descending pectinate series of five branches is visible.

Archedictyon as shown in Plate xxxvi.

Pigmentation evidently present, the wing being mottled in alternating areas of light and dark pigment, these areas being mostly squarish and tending to form irregular transverse fasciae; eight or nine such dark brown fasciae can be made out crossing the lighter parts of the wing from the costal margin on the part preserved.

The wing is almost certainly a forewing.

Type, Holotype, Specimen No. 20270, labelled "Beacon Hill, Deewhy," on underside of rock; in Coll. Mining Museum, Sydney, N.S.W.

The species is dedicated to its discoverer, Mr. Scully, to whom the thanks of all palaeontologists and entomologists are due for preserving it from destruction.

The photograph in Plate xxxvi was taken by Mr. W. C. Davies, Curator of the Cawthron Institute, to whom my thanks are due for this excellent result. In order to see the convexity and concavity of the veins correctly in this photograph, it should be looked at either from the broken basal end, or else with the posterior margin uppermost.

EXPLANATION OF PLATE XXXVI.

Mesotitan scullyi, n. sp., preserved portion of forewing. Order Protohemiptera, fam. Mesotitanidae. Length 86.5 mm. [W. C. Davies photo.

Postscript, added 2nd September, 1925.—Since the above paper was written, an artist friend of Mr. Scully has made a sketch of the insect, from Mr. Scully's recollections of it as it appeared when first discovered complete. This sketch shows some interesting points. Chief amongst these is the presence, on the somewhat large head, of a strongly projecting beak, such as is characteristic of the Order Protohemiptera. The bases of the forewings are greatly expanded, as in *Eugereon*, leaving no room for large hindwings. Towards the end of the abdomen are a pair of leaf-like processes, which I think are really the partially expanded apical portions of the partly folded hindwings, the rest of which probably lie close to or under the abdomen and would not therefore be noticed by Mr. Scully unless specially looked for.

NOTES ON AUSTRALIAN COCCIDAE WITH DESCRIPTIONS OF NEW SPECIES.

By Walter W. Froggatt, F.L.S.

[Read 28th October, 1925.]

During the time I was engaged in writing the Descriptive Catalogue of the Australian Coccidae, published as Science Bulletins by the Department of Agriculture of New South Wales, I received and collected a large number of undetermined species of Coccids from all parts of Australia. Among them I have some remarkable forms that I propose to work out and publish under the heading of Notes on Australian Coccidae.

In 1898 the late W. M. Maskell described a new species of *Lecanium* from specimens discovered in a cavity in the stem of *Casuarina* in Victoria under the name of *Lecanium casuarinae*.

In my investigation into the habits of Coccids, I have on several occasions found Lecaniums or the remains of Lecaniums in the cavities in branches or tree-trunks of our forest trees, usually in those occupied by ants. As the inner surfaces of these cavities are hard, dry and sapless, the larvae can apparently develop into adult females with very little moisture or apparent food.

It is difficult to give adequate descriptions of these curious forms, because usually the adult females have become rounded, dry structures with all the appendages aborted and hidden in the brittle sack or bubble, which represents the final development of the adult coccid. Still there are characteristic differences in the three species dealt with that are sufficient to separate them. In two the larvae were found sheltering under the adult coccid shell.

Lecanium eucalypti, n. sp.

This coccid in all stages of development was found firmly attached to the hard corrugated surface of a cavity in the stem of a small eucalypt growing in the forest at Brooklana, Dorrigo, 10.2.1925. The surface of the cavity was coated with fine brown kino, and covered with a resting colony of small black ants (*Crematogaster* sp.).

Adult ♀ dark reddish-brown, almost black turning to rich reddish-brown when treated with potash, and showing a fine granulated structure. Form variable, but usually sub-globular, with the apical margin having the anal cleft showing in an oval process in a depression raised well up from the outer margin of the body, which fits closely against the wood. The whole might be likened to a round brown bubble contracted round the edges, about one-quarter of an inch in diameter and one-twelfth of an inch in height.

Immature ♀ oval or shield-shaped, flattened down on the wood; reddish-brown, with a little floury secretion on both the upper and under surface.

Larva shield-shaped, dorsal surface slightly convex and segmented, with the anal segment rounded on either side of a deep anal cleft; outer margins finely striated, with slight lateral clefts. The antennae composed of nine irregularly shaped segments, the basal one forming a wedge-like process on either side of the rostrum, the second turning upward, third longer, 4th-5th shorter, 6th-7th swollen and rounded, 9th produced into a lance-shaped tip fringed with fine hairs. Legs well developed, with the femur thickened and the turn pointed. General colour light reddish-brown with black eyes.

Lecanium dixoni, n. sp.

I am indebted to Mr. C. French, Jr., for this interesting species. He received several specimens from Mr. J. E. Dixon, who found them in July, 1923, attached to the inner surface of a cavity in the stem of a *Loranthus*, parasitic upon a gum tree (*Eucalyptus* sp.) growing at Eltham, Victoria.

Adult ♀ about a quarter of an inch in diameter and of somewhat similar bubble-like form to that of the previous species. The derm lighter reddish-brown, with a narrow dark brown dorsal stripe from the front margin to the base of the anal cleft. The anal portion of the derm depressed above the hind margin, covered with fine irregular fovea. The anal cleft ridged on either side, forming a raised ridge, which in conjunction with a short ridge above, and short crossbar across the centre forms a cross-like pattern above the anal cleft.

Larva yellowish-brown, changing into rich pink when placed in potash. Dorsal surface shield-shaped, the central portion enclosed in a circular ring with a parallel ridge to the base of the anal cleft. The outer margin is flattened, forming a flange. The lateral marginal clefts well defined, anal cleft small. Legs long, femora thickened, tibiae long, fringed with fine hairs, tarsal claw small, and turned inward. Antennae long cylindrical, composed of six irregular joints, 1st short broad, 2nd very long, 3rd oval, about a third of the length of the second; 4th of a similar irregular oval shape, smaller and shorter, 5th not quite half the length of the 4th, 6th very small pointed and fringed with fine hairs.

Lecanium callitris, n. sp.

This species occurs in cavities under the bark of the Desert Cypress (*Callitris calcarata*) usually where wood ants have formed a nest. The species of ant, in whose nest this type was found is *Podomyrma bimaculata*.

I have on several occasions found the mature dead female coccids in such cavities as noted on page 30 of my "Descriptive Catalogue of the Scale Insects (Coccidae) of Australia."

During a recent visit to Forbes when examining a pile of cypress logs in a sawmill yard I found a cavity in one, containing a small colony of these wood ants, tenanted by several specimens of this Lecanium attached to the surface of the wood hidden under the dead bark.

Adult ♀ dark brown to almost black, with the margins of the derm crenulated and closely attached to the surface of the wood, the dorsal surface shagreened; the front margin arcuate giving it a somewhat heart-shaped form; the anal cleft very small. General form irregular, often varied from the shape of the cavity in which they have developed, broadly oval, and could be easily mistaken for a bubble-shaped mass of brown resin. Brittle and thin, forming an oval cavity beneath, all appendages aborted.

One specimen (not so mature) one-third of an inch in diameter, broader and more flattened than dead females. Front margin arcuate, outer edge finely crenulated, anal cleft small, lateral clefts distinct. Outer margin, central portion of the dorsal surface bright reddish-brown. Under surface convex, mottled with dull yellow, clouded with floury secretion. Antennae and legs aborted.

THE LABIAL PALPI OF *TRICHOPHYSETIS CRETACEA* AND *ARGYRIA AMOENALIS*.

By Alfred Philpott, Hon. Research Student in Lepidoptera, Cawthron Institute, Nelson, N.Z.

(*Communicated by Dr. A. J. Turner.*)

(Two Text-figures.)

[Read 25th November, 1925.]

While engaged in a study of the maxillae in the Lepidoptera, the writer came across two instances of very unusual structure of the labial palpi. In both cases the species belonged to the Pyralidae, one, *Argyria amoenalis* Butl., being placed in the subfamily Crambinae and the other, *Trichophysetis cretacea* Butl., in the Pyralinae. I cannot learn that these interesting instances have already been referred to; it will therefore be useful to have them described and figured.

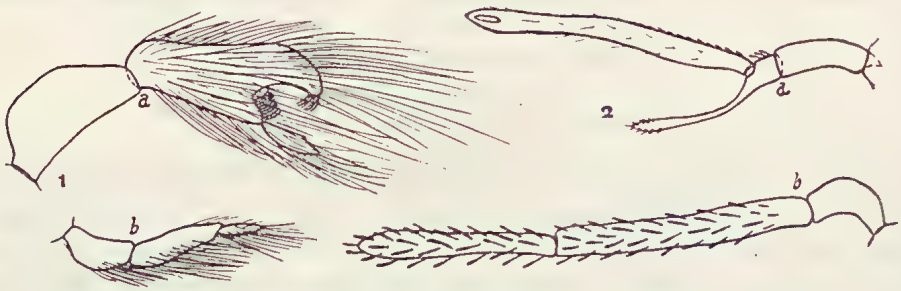
The labial palpi of the Lepidoptera are, on the whole, very uniform in structure. Such differences as there are arise, firstly, from their covering of hairs or scales, the extent and direction of which often result in greatly modifying the apparent shape of the segments; secondly, from the direction of the segments themselves, as drooping, porrect or curved upwards; and, thirdly, as the result of atrophy, the three original segments being sometimes reduced to two, or to one only; in a few instances the palpi have entirely disappeared. But in the vast majority of Lepidoptera the labial palpi consist of three more or less cylindrical segments, the first, or basal, being almost always a short one. A detailed account of the two interesting instances referred to above will now be undertaken.

Trichophysetis cretacea Butl.

In this species the basal segment of the palp in the male is of normal structure; it is cylindrical and slightly curved. The third, or terminal, also shows nothing unusual. It is long, cylindrical and blunt-pointed, and exhibits a prominent Johnston's organ at the apex. The second segment is greatly modified. It articulates in the usual manner with the first segment, but almost immediately gives rise to the third segment and extends inwards as a slender tentacle. This tentacle is a little less than half as long as the terminal segment and has its apical half slightly swollen and clothed with minute sensory hairs.

I am not aware of any other instance of a process being found on the second segment of the labial palp, though an apical process of the first segment occurs in some species of *Porina*, and in *Sabatinca*. The process in *Trichophysetis* is, however, perhaps more correctly to be regarded as the actual segment rather than an outgrowth, the articulation of the terminal segment having worked down from the apex to near the base of the second segment, and the portion of that segment left projecting having become modified into a tentacle-like structure. The female of the species has quite ordinary palpi.

The labial palpi of this species are, I believe, the most strangely modified in the whole of the Lepidoptera. The basal segment is stout, being much swollen ventrally. The second segment is also thick, but is broadened apically. On the upper surface of the broadened portion the organ is widely and deeply excavated. On the apex of the distal area of this excavation, and bending over it, is a dense patch of short, thick, slightly curved hairs. On the proximal portion is a similar, but more extensive, patch, directed towards the distal area. The third segment is reduced to a small subtriangular piece, articulating with the apex of the proximal side of the excavation. The whole of the second and third segments is covered with very long fine hair.



Text-fig. 1.—*Argyria amoenalis* Snel. Labial palp. *a*, male; *b*, female.
Text-fig. 2.—*Trichophysetis cretacea* Butl. Labial palp. *a*, male; *b*, female.

Argyria amoenalis Snel.

This curious apparatus is strongly suggestive of a strigil. The opposing tufts of hair would form the brushing apparatus, while the modified third segment would act as a spring to keep the organ undergoing the cleaning process pressed against these brushes. But the usual tibial strigils are present, so that it is hardly likely to be for the benefit of the antennae that the labial strigils have been developed. Is it possible that it may be the cleaning of the haustellum for which the structures are designed? But, if so, how is it that the female of *amoenalis* possesses quite ordinary palpi? Also, it seems probable that the apparatus is confined to this one species of the genus. *A. plumbolinealis* Hmpsn., *A. pentadactyla* Z. and *A. strophaea* Meyr. have been examined and found to possess normal labial palpi. A close study of the habits of both sexes of *Trichophysetis cretacea* and *Argyria amoenalis* might explain much in relation to the very interesting modification of their labial palps. Perhaps some Australian lepidopterist will, sooner or later, be able to throw light on the matter.

For the material on which this paper is based I have to offer my best thanks to Dr. A. Jefferis Turner who very kindly came to my assistance with various specimens.

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE FLORA OF NEW SOUTH WALES.

By W. F. Blakely,
National Herbarium, Botanic Gardens, Sydney.

[Read 28th October, 1925.]

Proteaceae.

Grevillea Shiressii, n. sp.

Frutex gracilis, 2-4 m. altus, ramulis novellis hirsutis; ramis angulatis; foliis anguste-lanceolatis, acuminatis, plus minusve trinervis, 8-16 cm. longis, 2-4 cm. latis; racemis axillaribus, floribus 5-8 pallide-violaceis; pedicellis gracilibus 12-15 mm. longis; perianthio lato plus minusve gibberoso, lobis linearibus apicibus connatis; stylo perianthium excedente, 10-15 mm. longo; ovario glabro, stipitato; fructo oblique-cylindrico, costato, vel sulcato, cum stylo pedicelloque 5 cm. longo, 7-9 mm. lato; seminibus lineari-ovatis marginibus revolutis 10-12 longis, 3 mm. latis.

Slender, graceful shrubs, 6-25 feet high, glabrous, except the minute shoots which are infested with pale, rufous, silky hairs; branchlets angular or compressed. Bark slightly rough, reddish-brown throughout. Leaves narrow, lanceolate, terminating in a rather long curved point, somewhat triplinerved, venulose on both surfaces, undulate, shining above, dull and much paler underneath, the midrib prominent on both sides, the intramarginal vein distant from the edge, giving the leaf a triplinerved appearance, lateral veins distinct, forming an angle of about 45° with the midrib; the nerve-like margins diminishing into the moderately short, compressed petiole, 8-16 cm. long, 2-4 cm. broad. Inflorescence axillary, forming short racemes of 5-8 flowers, glabrous, except the common peduncle, which is infested with minute, deciduous, silky hairs. Flowers pale violet to greenish, tinged with pale purple-brown; pedicels slender, terminating in a linear, lanceolate, dilated green, persistent bract-like expansion which extends to the fissure of the corolla, 12-15 mm. long, the dilated portion 5-8 mm. long. Buds obliquely clavate, inflated in the lower half. Corolla broad, somewhat gibbose, the segments linear, their apices connate, orbicular, the broad basal portion minutely glandular, hispid inside. Style exceeding the corolla, 10-15 mm. long, pale green, somewhat obscurely striate; the striae extending into the stipes. Stigmatic disc oval, apiculate, 2.5 mm. long, 1.5 mm. broad. Ovary glabrous, stipitate, the stipes purple-brown, and nearly as long as the style. Fruit obliquely cylindrical, pale brown, with 8-10 faint longitudinal lines or ridges, including the style and stipes, 5 cm. long, 7-9 mm. broad in the middle. Seeds narrow-ovate, rather acute at both ends, the margins revolute, forming ventral surface, the back convex, marked with three or more faint lines, 10-12 mm. long, about 3 mm. broad.

Description of Seedlings.—Hypocotyl slender, slightly compressed, 3-5 cm. long. Cotyledons obovate or oblong, hastate, thick and veinless, dark green, 10-13 mm. long, 4-5 mm. broad. First pair of leaves sessile, narrow lanceolate, with a slightly curved mucro, attenuated at the base, the lamina reaching to the stem, obscurely penninerved, light green. Stem slightly angular or compressed; the growing point tipped with rufous, silky hairs. Out of three seedlings examined, the first leaves were alternate on two, and opposite on the other.

Range.—So far the species has only been found at Mullet Creek, Hawkesbury River, about 1 mile northwest of Wondabyne railway platform, 40 miles by rail north of Sydney. It extends from the head of the salt water of Mullet Creek, as far as the northern arm, a distance of about a mile and a quarter. (D. W. C. Shiress and W. F. Blakely, 24/12/1922.)

Named in honour of David William Campbell Shiress, my friend and companion on many botanical excursions during the last fourteen years.

G. Shiressii is an attractive looking shrub, with light green, undulating leaves, and it seems to belong to section Lissostylis, but it does not appear to have any very close affinities amongst the Eastern species, and for the present it is placed next to *G. oleoides* Sieb., because of its long leaves.

Tremandraceae.

Tetratheca Shiressii, n. sp.

Caulis debilis, teres, glaber, vage ascendens ad 3-9 dm. ramis paucis; folia rara, sessilia vel brevi-petiolata, lineari-lanceolata, quasi minutis glandulis denticulata, inferiora rara alternata, 10-25 mm. longa, 3-4 mm. lata, superiora 3-4 in verticillo; flores axillares et terminales, pedicillis curvatis, 10-20 mm. longis, sepalis 4, lanceolatis, 4 × 2 mm.; petalis 4, erubescentibus angusto-lanceolatis, 10 × 4.5 mm.; staminibus 8, antheris quadrangularibus, ovario glanduloso-pubescente, stylo simplice, terete, capsula cuneata, minute glanduloso-pubescente, 6-8 × 5 mm.

A weak scrambling undershrub, 1-4 feet high, or frequently prostrate, glabrous except for a minute glandular vestiture on the nascent parts; internodes 3-10 cm. long; leaves few, very variable, rather distant, sessile or shortly petiolate; the lower ones opposite, and usually in whorls of three, linear lanceolate to elliptical-lanceolate, paler underneath, the margins recurved, and minutely glandular-denticulate, 10-20 mm. long, 3-4 mm. broad; upper leaves usually in pairs, linear, acute, straight or curved, 10-25 mm. long, 1-4 mm. broad; flowers axillary and terminal, solitary or in pairs, on slender, curved, slightly dilated pedicels, 10-20 mm. long; sepals 4, dark purple-brown, lanceolate, one-nerved, 4-5 mm. long, 2 mm. broad; petals 4, light pink, narrow-lanceolate, 10-15 mm. long, 4-5 mm. broad, or one or two slightly broader than the others; stamens 8; filaments about 1 mm. long; anthers somewhat quadrangular, linear-oblong, minutely hispid along the angles, dark coloured or nearly black, except the yellow top; ovary glandular-pubescent, shorter than the anthers; style simple, terete, nearly 3 mm. long, the lower half pink, the upper half white; stigma very small, scarcely perceptible; capsule cuneate-ovate, minutely glandular-pubescent, and somewhat viscid, slightly venulose, 6-8 mm. long, 5 mm. broad; seeds pubescent, almost triangular, 3 mm. long, with a white caruncle about 1 mm. long.

Range.—Heathcote, J. Foster; Kariong Trig., three miles northwest of Wondabyne, Hawkesbury River district; very common over a wide area. It grows in all kinds of situations, sometimes from the crevices of bare rocks, in hard, dry

sandstone rubble, in swampy and semi-swampy land, and in thickets of *Angophora cordifolia*. In the latter situation it scrambles up through the *Angophora* to a height of five feet. D. W. C. Shiress and W. F. Blakely, the Type; on the east side of Sugarloaf Trig., and at the head of Patonga Creek; Gosford district, J. Foster.

Among the New South Wales species, *T. juncea* Sm., appears to be its nearest affinity, from which it differs greatly in size and habit, in the long terete branches, more variable leaves, especially the upper ones and larger flowers with their longer, filiform pedicels.

Araliaceae.

Astrotricha crassifolia, n. sp.

Fruticulus virgatus 6-12 dm. altus, ramis juvenilibus floribusque tomento brevo incano vel ferrugineo vestitis, ramis glabrescentibus; foliis alternis, breviter petiolatis, erectis, rigidis, lineari-oblongis valde obtusis, crassis, canaliculatis, supra laevibus nitidisque, subtus tomentosis marginibus valde revolutis, 2-5 cm. longis, 3 mm. latis; paniculis angustis, terminalibus vel in axilibus superioribus; floribus breviter pedicellatis, 4-14 in umbellis; alabastris clavatis, pedicellibus, crassis, quam flores brevioribus; calycis lobis prominentibus, petalis reflexis, mucronatis, extra tomentosis, intra glabris; antheris oblongis, versatilibus, quam filamentos brevioribus; fructis maturis ovati-vel lati-oblongis, glabris praeter annulum hirsutum densum ad apicem.

A small virgate shrub 2-4 feet high, the young branches and inflorescence covered with a close, hoary, ferruginous, floccose tomentum, the old branches quite glabrous. Leaves alternate, petiolate, erect and rigid, linear-oblong, very obtuse, thick, canaliculate, smooth and shining above, flocculent beneath, the midrib obscure, the margins strongly revolute, 2-5 cm. long, 3 mm. broad; petioles compressed, 3 mm. long. Inflorescence terminal and in the upper axils, the whole rarely exceeding 6 cm. long; umbels of 3-14 shortly pedicellate flowers, buds shortly clavate, and like the thick pedicels, densely floccose. Calyx teeth prominent. Petals 5, reflexed, densely floccose, glabrous within, one-nerved, mucronulate; stamens 5; filaments filiform, pilose; anthers oblong, versatile, shorter than the filaments; styles slightly protruding, rather thick, with more or less incurved stigmas. Ripe fruit compressed, ovate to broadly oblong, somewhat thick and venulose, glabrous, except for a dense floccose ring at the top.

Range.—Only known at present between Warrah Trig. and Woy Woy, on the northern portion of Broken Bay. D. W. C. Shiress and W. F. Blakely.

Affinities.—*A. crassifolia* is closely allied to *A. ledifolia* DC., and the characters which separate it from that species are the thick, rigid, linear, strongly revolute, very obtuse leaves, shorter inflorescence, longer points to the calyx, and differently shaped fruits.

From *A. linearis* A. Cunn., it is distinguished by its broader and shorter, smooth, obtuse leaves, longer calyx points, and longer and more oblong fruit.

Compositae.

Olearia Stilwellae, n. sp.

Fruticulus 3-6 dm. altus, radicibus carnosis crassisque; caulibus erectis, pedunculis et caulibus juvenilibus capillorum bifurcatorum vel simplicium tomento incano vel rufo vestitis; foliis alternis, petiolatis, angusti-vel lati-oblongis, nonnumquam obtusi-lanceolatis, minute denticulatis, supra fusci-viridibus

glabrisque, subtus tomentosis, 4-11 cm. longis, 2-3.5 cm. latis; capitulis mediocriter magnis, solitariis, axillaribus, pedunculis 10-19 cm. longis; involucris turbinatis 2 cm. longis; bractis imbricatis acuminatis extra semiglabris; bractis interioribus scariosis discum excendentibus; radiis ligulis albis vel coerulis 15-18 mm. longis; floribus disci numerosis; corolla glabra 10 mm. longa; acheniis linearibus sericeo-tomentosis, 5 mm. longis; setis pappi numerosis, barbellatis, inaequalibus.

A dwarf herbaceous shrub, with thick, fleshy roots and erect stems 1-2 feet high, the young stems and pedicels, and under side of the leaves clothed with a dense, hoary or reddish, silky tomentum, consisting of simple and bifurcate, silky hairs. Leaves alternate, petiolate, narrow to broad oblong, or obtusely lanceolate, minutely denticulate, the denticulations erect and asperate, dark green and glabrous above, silky-tomentose beneath, 4-11 cm. long, 2-3.5 cm. broad; venation distinct, channelled above, prominent beneath; petiole terete or nearly so, canaliculate, 5-20 mm. long. Flower heads moderately large, on axillary peduncles 10-19 cm. long, with two or three small floral leaves along them.

Involucres turbinate, 2 cm. broad at the top; bracts imbricate, acuminate, semiglabrous on the back, the inner ones scarious, exceeding the disc; the outer ones thick and of the same colour and vestiture as the peduncles. Ray florets 10-12, the ligular pale blue or white, 15-18 mm. long; disc florets more numerous, the corolla glabrous, 10 mm. long; anthers of the disc florets acute at the base, terminating in long, protruding points; style lobes long, minutely glandular, compressed-acuminate, flexuose. Achenes linear, silky-hairy and slightly striate, 5 mm. long. Pappus bristles barbellate, unequal, the inner ones exceeding the outer ones.

Named in honour of Miss Sylvia Stilwell, who with Mr. D. W. C. Shiress discovered this beautiful species at Nana Glen, 35 miles south of South Grafton.

O. Stilwellae belongs to section Dicerotriche, and its thick, fleshy roots seem to distinguish it from all the other species. It is closely allied to *O. pannosa* Hook., from which it differs in the differently shaped, denticulate leaves, much smaller turbinate involucres, pointed anthers, more highly coloured tomentum, and in the fleshy roots.

From *O. grandiflora* Hook., it is distinguished by its narrower and minutely denticulate leaves, different venation, smaller involucres, and acuminate bracts.

TWO NEW SPECIES OF SILKY LACEWINGS (FAMILY PSYCHOPSIDAE, ORDER NEUROPTERA PLANIPENNIA) FROM AUSTRALIA.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.R.S., F.N.Z. Inst., F.L.S., F.G.S., F.E.S., C.M.Z.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Plate xxxviii.)

[Read 28th October, 1925.]

The rare and beautiful insects belonging to the family Psychopsidae, or Silky Lacewings, have their headquarters in Australia, where ten species are already known; in addition to these, there are only three or four other known species, found in South Africa, Burma and China. The family is a very ancient one and originally spread all over the world; fossil remains of its ancestors have been found in the Upper Triassic of Ipswich and in the Liassic and Upper Jurassic beds of Europe.

Two fine new species are here described, bringing the Australian total up to twelve. One of these comes from Central Queensland, and was discovered by Mr. W. B. Barnard, of Toowoomba, to whom it is dedicated. His specimens were given to Mr. R. Illidge, of Brisbane, who very kindly presented them to me; one of them is being presented by me to the Queensland Museum. The other is a unique specimen from Roebourne, W.A., sent for description by Mr. Glauert, Biologist of the Western Australian Museum, Perth. The photographs from which Plate xxxviii has been prepared were taken by Mr. W. C. Davies, Curator of the Cawthron Institute, to whom my best thanks are due.

These insects are evidently attracted to light on warm, still nights, and I think a considerable number of new species might yet be found in out-of-the-way parts of Australia, if they were looked for by this means between October and March. As each species is only out on the wing for a short time, collectors should note the date of capture; the Roebourne species has only the year (1920) on the label, and this will make it less easy to obtain more of it.

Undoubtedly the easiest way to obtain specimens of this family is to obtain the larvae from under the bark of Eucalypts. Only rough-barked trees should be selected, with fresh, healthy bark on them, and the best places to search are round the edges of a gum-flow or near large cracks in the bark. The bark should be levered up with a chisel or wooden wedge, and the characteristic grey pubescent larvae, with their large calliper-like jaws, will be found either on the raised bark or on the wood beneath it. As these larvae are cannibals, only one should be kept in each tube; the tubes must be kept dry and well aërated, the open ends being stopped with cotton-wool.

Family Psychopsidae.

Genus Psychopsis Newman.

Psychopsis barnardi, n. sp. Plate xxxviii, fig. 1.

♂. Total length 10 mm.; forewing 19 mm.

Head small, 1.6 mm. wide; eyes dark greyish-brown, mottled; antennae pale testaceous basally, shading to dark brown distally (apices missing). Epicranium pale testaceous, varied with livid greyish; vertex and frons dark brown, except for pale testaceous areas surrounding the antennae, the brown thus forming a kind of X-mark with the four arms reaching to the eyes; surmounting this mark, on the epicranium, is a smaller, diamond-shaped, median area of brown, not quite as dark. Clypeus, labrum, labium and palpi all pale testaceous.

Thorax: Prothorax pale testaceous, pronotum covered with dense hairs of same colour. Mesothorax shading from medium testaceous anteriorly to dull brownish posteriorly. Metathorax brownish with livid greyish markings on pronotum. Legs short, pale testaceous, apices of tibiae and tarsi dark brown.

Wings: Forewing 11 mm. wide at tornus, hindwing 9 mm. wide at same place. Rs with 13-15 descending branches before end of *vena triplica* in forewing, 11 such in hindwing. M_{3+4} in forewing fusing with Cu_1 about half-way. Posterior margin of both wings concave distally, that of hindwing only slightly so; tornus of forewing very prominent. Both wings with a complete series of costal crossbars and three complete series of gradate crossveins; forewing also with from four to seven crossveins forming the upper half of an additional gradate series on disc, between basal and middle series. Forewing subhyaline, the veins pale testaceous, the membrane slightly tinted. On the *vena triplica*, at one-fourth from base, is a rounded, reddish-brown spot 1.2 mm. in greatest diameter, with darker border; from it two blackish lines diverge posteriorly to M, where they join with the irregular brownish markings along the posterior margin. In the apical half of the wing, three fasciae are present, each irregular in form, narrow, and bordered on either side by a fine blackish line; the most basal of these fasciae is not darkened between the lines, but the other two are shaded brownish; the three fasciae converge together strongly towards the tornus, but the most distal one, lying close to the termen, ends up before reaching the other two; these latter, however, join together to form a brown blotch which runs into an irregular patch of bright reddish-brown above the tornus, bordered by three small black dots. About half-way between costa and tornus are two larger black spots, one lying on the distal side of each of the first two fasciae before they merge; there is also a very small black spot in the brown blotch below them. Along Cu and between it and posterior margin are some irregular brownish blotches, from one of which, at about three-fifths from base, an oblique black line runs upwards for nearly 2 mm., suggesting the beginnings of the formation of an extra fascia. Both costa and termen are lightly mottled with markings of pale brownish testaceous. Hindwing with dull creamy veins, and hyaline, iridescent membrane. A large blackish, oval spot, 2 mm. in greatest diameter, lies below end of the *vena triplica*, and a slight brown cloud around tornus, with indications of one or more dark spots on the tornus itself.

Abdomen dull medium brownish above, with indistinctly outlined darker markings mid-dorsally and laterally on segments 2-8. Segments 9-10 pale testaceous, forming a large bulb carrying a pair of large and very hairy surgonopods, valve-shaped, depressed, with apices convergent and well rounded; basally, touching the lateral raised margin of the bulb on either side, is a small nodular

swelling lying in a slight hollow of the outer face of each surgonopod. Tergite of segment 9 projecting between these two surgonopods as a sharp process nearly as long; viewed laterally, it is bifid, the upper branch being short, sharp and tooth-like, the lower longer, lobed in the vertical plane and well rounded.

Habitat.—Central Queensland.

Types.—Holotype male in Cawthron Institute Collection and paratype male in Queensland Museum, Brisbane, both taken at Blackwater, Central Queensland railway, on 9th Nov., 1922, by Mr. W. B. Barnard, to whom this species is dedicated. The paratype is larger than the holotype (forewing 22 mm.) but has a small piece missing from above the apex of the left forewing, and does not show the structure of the ninth tergite, owing to the surgonopods being tightly closed. Two other males in Cawthron Institute Collection, one taken by Mr. Barnard at Huntley Station, Central Queensland railway, on 10th Nov., 1921, and one by Mr. E. J. Dumigan at Clermont, Central Queensland, on 15th November, 1924.

This species comes nearest to *Ps. gracilis* Till., from which it can be at once distinguished by its much more robust build, broader and hairier wings, less angulated tornus in both wings, larger black spot on hindwings, and marked differences in the fasciation and other markings of the forewing; in particular, the dark patch in basal part of forewing touches the base in *Ps. gracilis*, but is one-fourth of the length of the wing from base in *Ps. barnardi*, n. sp. The new species is also related, but less closely, to *Ps. mimica* Newm., *Ps. margarita* Till. and *Ps. elegans* Guér.

PSYCHOPSIS MACULIPENNIS, n. sp. Plate xxxviii, fig. 2.

♂. Total length 10 mm.; forewing 19 mm.

Head pale ferruginous; eyes dark grey; antennae pale testaceous basally, shading to dark brown distally.

Thorax pale dull testaceous tinged with ferruginous at bases of wings. Legs pale testaceous tinged with ferruginous on femora.

Wings dull creamy all over, the costa slightly darkened. Forewing only 10 mm. wide at tornus, hindwing 9 mm. wide at same place. Rs with 15-16 branches before end of *vena triplica* in forewing, 12-13 such in hind. Posterior margin not concave distally in either wing, tornus not prominent. M_{3+4} in forewing fusing with Cu_1 only for a short distance, well beyond middle, then separating again. Both wings with a complete series of costal crossbars and three complete series of gradate crossveins; of these the discal one in forewing tends to become doubled, and there are also a few extra crossveins in the disc. Forewing with three dark spots along *vena triplica*, each being blackish on the membrane but bright ferruginous when crossing a vein; of these, the basal one is the largest, reaching down into the disc below Rs; the middle one is smaller, only extending from Sc to Rs; the distal one is very small; there is a suspicion of a fourth spot towards end of *vena triplica*. Just beyond end of *vena triplica* is a larger, dark brown, semicircular spot, and below this a small dark blotch on the gradate series. The costa carries four small dark spots, one obliquely above each of the four already mentioned. On the posterior margin are five small but well-defined black spots, three in the basal half and two in the distal; there is also a very small black spot on the termen, a little beyond tornus. Hindwing with an oval blackish spot, 1.6 mm. in greatest diameter, just below end of *vena triplica*.

Abdomen dark brownish above, pale testaceous on sides and beneath. Surgonopods pale testaceous, hairy, in the form of broad valves; tergite of segment 9 projecting slightly between their bases as a short, button-like process.

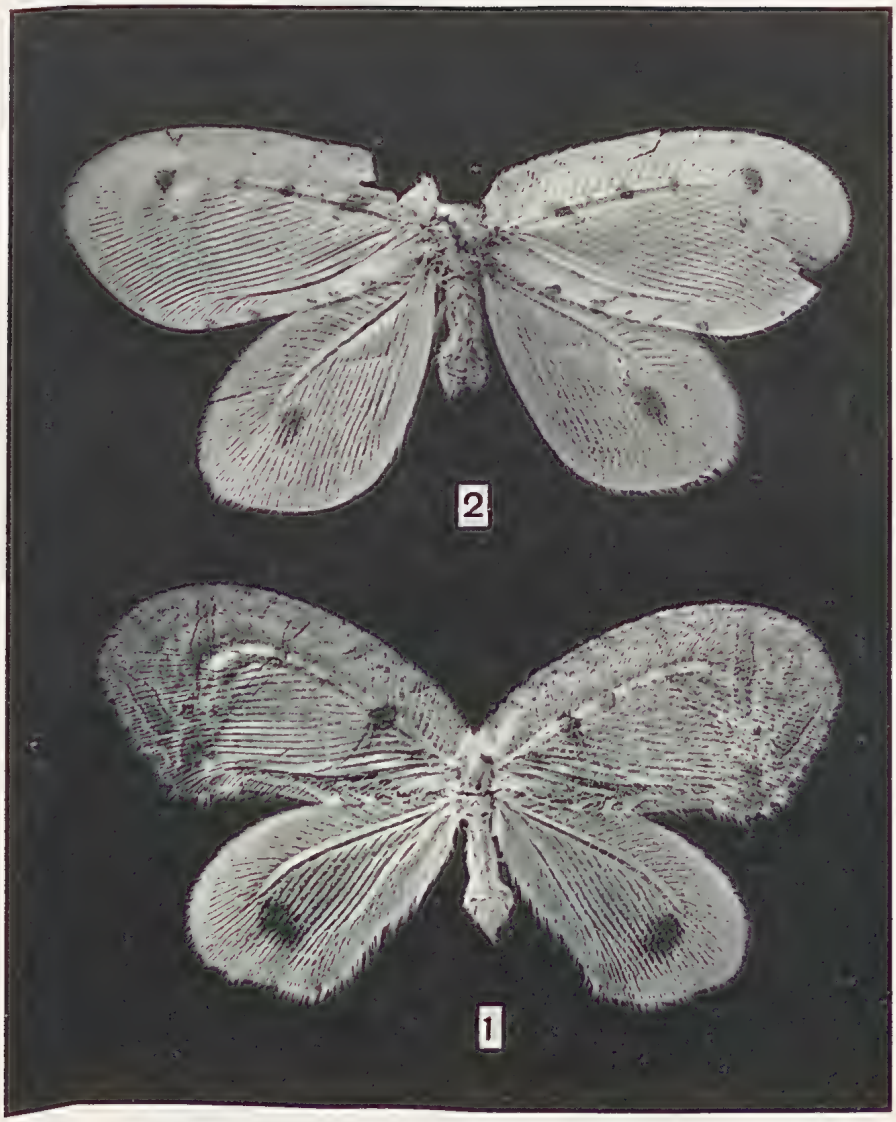
Habitat.—Roebourne, W.A.

Type.—Holotype male (unique) in Western Australian Museum, Perth, W.A.; label "1920—130/ Roebourne".

Cawthron Institute, Nelson, N.Z. 10th Sept., 1925.

EXPLANATION OF PLATE XXXVIII.

Fig. 1 (below) :—*Psychopsis barnardi*, n. sp., holotype male. Expanse 38 mm.
Fig. 2 (above) :—*Psychopsis maculipennis*, n. sp., holotype male. Expanse 41 mm.



1. *Psychopsis barnardi*, n. sp. 2. *Psychopsis maculipennis*, n. sp.

NATIONAL MUSEUM
VICTORIA

THE ANATOMY OF *LINDSAYA LINEARIS* AND *LINDSAYA MICROPHYLLA*.

By May M. Williams, M.Sc.

(Thirty-four Text-figures.)

[Read 28th October, 1925.]

Introduction.

On account of recent anatomical investigation on the rhizome of the genus *Lindsaya*, many new and interesting facts have been revealed. These facts have led to a great deal of discussion, but at present it is generally accepted that the type of stele characteristic of the genus is one which is intermediate between the protostele and the solenostele. The primitive nature of the stelar structure is of further interest since the plant presents other features which are relatively advanced.

This form of anatomy, generally known as the "Lindsaya-type", was first observed in *Davallia repens*, a form closely allied to the Lindsayas, by Trécul in 1885. Unfortunately this investigator overlooked the most interesting features. In 1902, Tansley and Lulham described this type of stele for five species of *Lindsaya*. It was these investigators who gave it a perfectly correct interpretation. Gwynne-Vaughan, in 1903, described further interesting forms in the sequence of events leading from the Lindsaya-type of stele to the solenostele. The most recent work is that of McLean Thompson, published in 1920, who describes the stele in terms of the ontogeny.

The species described in the present communication are two which are of relatively common occurrence in New South Wales, namely, *Lindsaya linearis* (Swartz.) and *Lindsaya microphylla* (Swartz.). In some instances they occur in fairly dry sandy soils associated with such types as *Schizaea bifida*. Under these conditions they show features typically associated with xerophily. In other instances they occur in fairly moist positions, when the leaves show a filmy nature. *L. linearis* particularly is often found in very swampy country.

The ferns are quite small, with creeping rhizomes which often show dichotomous branching. In *L. linearis* the fronds are from a few inches to a foot in height, the sporophylls usually taller than the ordinary leaves. The rachis is dark and shining. The pinnules are entire or nearly so, and usually distant. In *L. microphylla* the fronds are thin, with a slender, usually flexuous, rachis. The barren pinnules are lobed. In both species the sori are continuous.

The various parts of the plant were fixed in the field in a 1% chromo-acetic solution and passed in the usual manner into paraffin. Sections were then made of the various parts varying from 3μ to 12μ in thickness and stained in Flemming's triple stain, this proving very satisfactory for all parts of the plant.

Investigation.

A. *Rhizomes.*

The rhizomes of both types are covered by a fairly extensive development of scales which become very profuse around the apex. The rhizomes show a fairly regular dichotomous branching which, although uncommon among the Polypodiaceae as a whole, has been observed in numerous species of *Lindsaya*, and seems to be a fairly constant feature of the genus. These branches bear the same structure as the main axis from which they arise.

The apices of the stems are alike in both forms and are of the general nature described for Polypodiaceous types. This is indicated in Text-fig. 1, where it will be observed that the apex consists of a small cone, slightly raised above the general level of the rhizome, and terminated by a large initial cell, tetrahedral in shape, which is deeper than broad. Segmentation takes place in the usual manner, segments being cut off parallel to the cutting faces of this cell. These segments are further divided into one inner cell and two outer cells. The latter give rise to the cortex and epidermis, the former to the vascular system of the rhizome.

Behind the apex, the cortex becomes sclerized and from the outer limits scales arise. Siliceous nodules, often irregularly shaped, occur in the cortical cells.

The vascular systems of the rhizomes of both types have been mentioned as conforming with the "Lindsaya-type" by Gwynne-Vaughan and Bower. This is further indicated in Text-figs. 2-4. These figures represent sections made from the internodes of the respective types. It will be observed that the greater part of the bundle is occupied by xylem, accompanied by xylem-parenchyma and surrounded by phloem, pericycle and endodermis. Towards the upper or dorsal surface of this solid core of xylem, a pocket of internal phloem associated with internal parenchyma occurs. The dorsal mass of xylem is very thin, forming a bridge over the internal phloem, while the ventral mass of xylem is very much thicker. The xylem tracheids are of fairly uniform size and are composed solely of scalariform elements; spiral or annular tracheids corresponding to the

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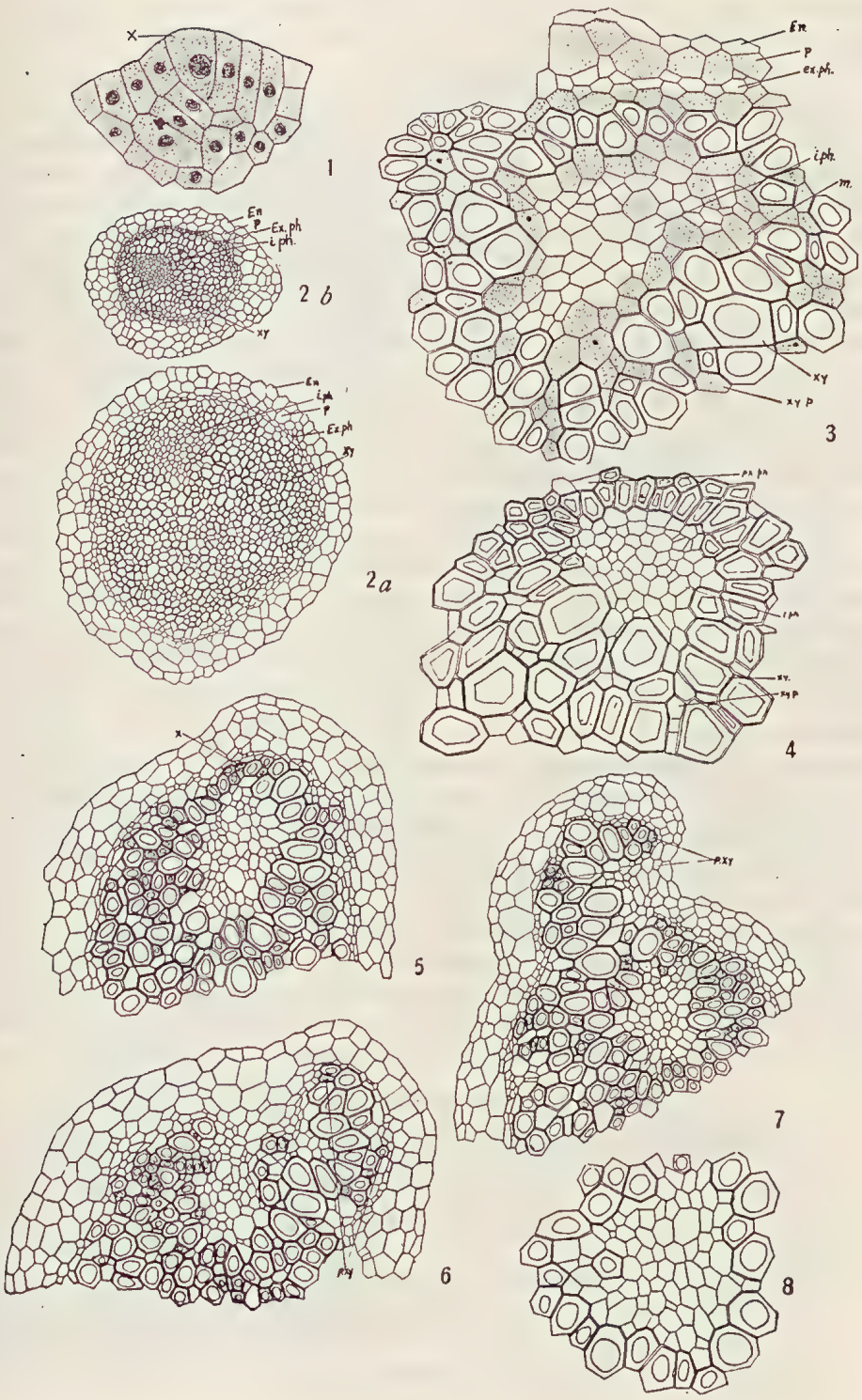
Text-figures 1-8.

1. A longitudinal section of the stem apex of *Lindsaya microphylla* showing the tetrahedral apical cell (X) and the typical segmentation. × 180.
2. Transverse sections of the vascular bundles of *L. microphylla* (*2a*) and *L. linearis* (*2b*), showing the central core of xylem (*xy*) with its internal phloem (*i. ph.*) surrounded by external phloem (*ex. ph.*), pericycle (*p*) and endodermis (*en*). × 40.
3. A transverse section of the dorsal portion of the vascular bundle of *L. microphylla*. *xy. p.*, xylem parenchyma; *xy.*, xylem; *i. ph.*, internal phloem; *m.*, internal parenchyma; *ex. ph.*, external phloem; *p.*, pericycle; *en.*, endodermis. × 180.
4. A transverse section of the dorsal portion of the vascular bundle of rhizome of *L. linearis*. × 180.
5. The same as the above except that a leaf trace is about to depart, forming a small dorsal projection. The break in the continuity of the dorsal arc of xylem will occur in the vicinity of *x*. × 100.
6. A stage further advanced in the departure of the leaf trace. The dorsal arc of xylem has broken and rotated laterally outwards. Internal and external phloem are in communication. *p. xy.*, protoxylem. × 100.
7. The gap caused in the xylem by the departure of the leaf trace has again closed. × 100.
8. A transverse section of the internal phloem showing xylem tracheid incorporated within it. × 180.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protoxylem were not observed, although a careful search was made for them. Xylem parenchyma is more abundant in the rhizome of *L. microphylla* than in that of *L. linearis*.

The "internal pocket" is composed of phloem and parenchyma. In *L. linearis*, this parenchyma consists solely of a layer of cells separating the xylem and phloem; in *L. microphylla*, the internal phloem itself has a few intermingled parenchymatous cells as well. The sieve tubes of both the internal and external phloem are of fairly uniform size, and show no differentiation into protophloem and metaphloem, protophloem elements not being present in the stem. It is interesting to note in this connection that Gwynne-Vaughan describes protophloem as being present on the outer margin of the external phloem of *Davallia repens*. The external phloem consists of one or two rows of sieve tubes surrounding the xylem and separated from it by a layer of parenchymatous cells. The pericycle is composed of large cells, two to four cell layers deep and surrounded by the characteristic endodermis. The root trace departs from the outer margin of the ventral portion of xylem directly opposite the dorsal arch and passes through the cortex with the minimum of disturbance. The leaf trace comes off as a single curved strand, in departing breaking the dorsal arch of xylem, thus placing the internal and external phloem in communication (Text-figs. 5-7).

Text-figure 5 represents a section approaching the node, and it will be observed that here the internal phloem has formed a projection resulting in a thrusting up of the dorsal arc of xylem in its vicinity. This is brought about by an increase in the amount of phloem present in the stem, causing this dorsal projection in order to accommodate the added bulk. The phloem now commences to extend laterally outwards; the strain thus set up causes a breaking at the dorsal arc at a point X (Text-fig. 5), where this dorsal projection meets the unaltered part. This break in the continuity of the dorsal xylem places the internal and external phloem in communication. There is no involution of the endodermis. The free end of the xylem then commences to rotate laterally outwards, and is closely followed by the internal phloem. Thus the internal phloem of the leaf trace is derived from the internal phloem of the bay. This condition is indicated in Text-fig. 6. A wide gap is formed in the stelar tissues as a result of the movement of the arc, and the free communication of the internal and external phloem is very pronounced at this point. It is here that protoxylem elements begin to make their appearance in the trace which had hitherto been without them. The arc of xylem now commences to raise itself from the dorsal surface of the broken stele, and deepens its concavity so as to take on a gutter-

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Text-figures 9-15.

9. A longitudinal section of the apex of the petiole of *L. linearis* showing the wedge-shaped apical cell forming two rows of segments. × 200.
10. A transverse section of the petiole of *L. linearis*. × 45.
11. A transverse section of the petiole of *L. microphylla*. × 25.
12. A transverse section of the petiolar bundle of *L. microphylla* showing three protoxylem groups (*p. xy.*) and ∩ shaped mass of metaxylem surrounded by phloem pericycle and endodermis. × 200.
13. A transverse section of the petiolar bundle of *L. linearis*. × 200.
14. A transverse section of the pinnule of *L. linearis* showing upper and lower epidermis with thick cuticle, stomata confined to the lower surface, and spongy mesophyll. × 110.
15. A longitudinal section of the root apex of *L. linearis* showing the pyramidal apical cell with its segmentation, and the root cap. × 200.

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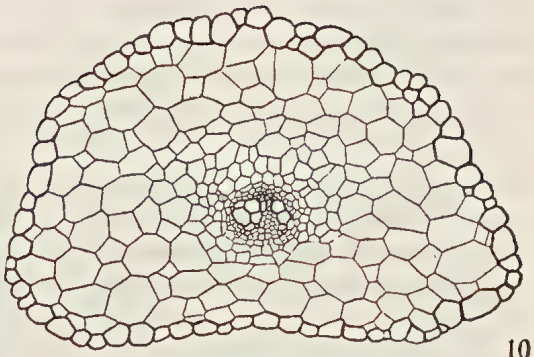

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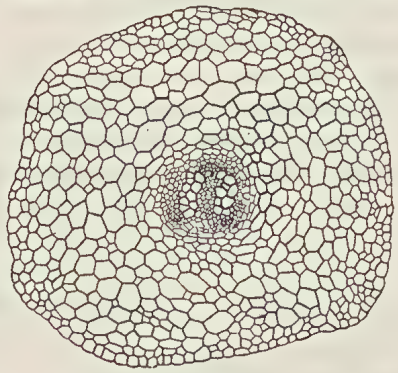

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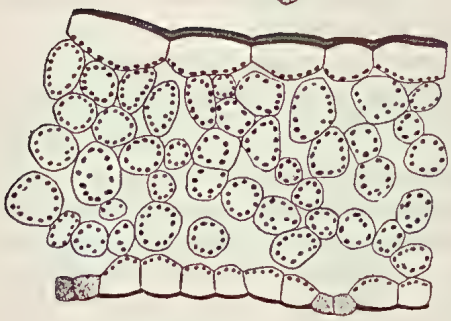

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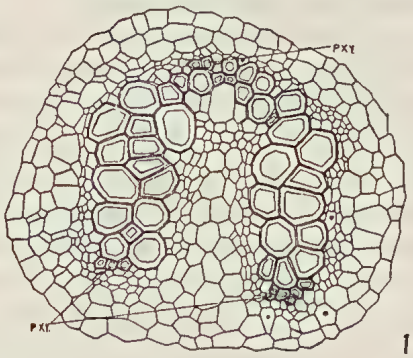

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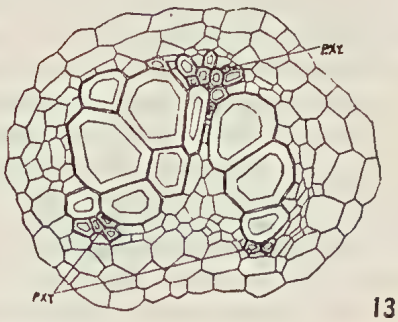

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shaped form. The broken dorsal vault again becomes complete before the leaf trace is properly detached (Text-fig. 7). The arc of xylem continues to raise itself until it becomes detached from the xylem of the stem. At the same time the external phloem, pericycle and endodermis become folded in until, finally, complete separation of the two structures is brought about and the meristele of the petiole is formed, its plane of symmetry being parallel to the dorsal surface of the stele.

These facts are in very close agreement with those described by Tansley and Lulham (1902, pp. 158-9) in *L. orbiculata*, with one important difference, namely, that no internal endodermal cells appear in the internal phloem in connection with the departure of the leaf trace. These investigators have stated that "as the free end of the arc moves away from the stele the internal endodermis approaches the outer one, they touch and open, thus placing the inner strand of parenchyma which had dilated considerably into connection with the cortex". In *L. microphylla* and *L. lincaris* the leaf trace, as it separates, is always limited externally by unbroken endodermis. Although not directly stated, it seems that the underlying idea of these authors is that the internal pocket arose by flow of tissue, the parenchymatous cells being derived from the cortex.

McLean Thompson (1920, p. 727), who describes the structure in terms of the ontogeny, considers that "the formation of medulla and inner phloem involves neither cortical intrusion nor tissue flow, but is the result of static intrastelar change by which also the pockets in the adult stele arise."

During the course of the investigation, the writer observed the presence of isolated tracheids in the internal phloem pockets, further indication of change of procambial destination of cells *in situ* (Text-fig. 8). This is the idea put forward by Bower.

It is generally recognized that the great interest of the "Lindsaya-type" of stele is that it appears to furnish a phylogenetic link in the sequence from the protostele to the solenostele. Gwynne-Vaughan (1903, p. 717) expresses very concisely the nature of this change: "As the leaf and the trace increased in importance relative to the stem, the phloem lying on the adaxial side of the leaf trace became extended downwards into the substance of the xylem of the protostele. Gradually reaching further down through the internode, this internally decurrent phloem at length comes into contact with that decurrent from the leaf trace below, and a continuous solid core of phloem was thus formed within the stele. Then the ground tissue lying in the adaxial concavity of the leaf trace also began to extend downwards into the stele forming at first a prolongation that ended blindly in the core of phloem but eventually it reached down from one leaf trace until it met with that decurrent from the next leaf trace above. In this manner an internal strand of ground tissue was formed which is continuous throughout the stem and the stele became a solenostele".

This mode of formation of the solenostele implies that there was present a continuous core of internal phloem before the ground tissue became decurrent at all. But, taking into consideration Boodle's (1901) description of the structure of the node of *Gleichenia flabellata*, it appears that phloem and ground tissue were decurrent together into the xylem of the protostele. It follows that the solenostele may have originated by either of these two methods, and does not necessarily come along one line of descent.

Another feature of interest with regard to this "Lindsaya-type" of stele is that it has frequently been described in the ontogeny of higher types of stele. Since

Lindsaya presents other features which are relatively more advanced, Bower (1918, p. 61) considers that *Lindsaya* may be held to have stood still anatomically at an early stage of the ontogeny, a fact possibly related to its restricted leaf development, while others with more ample leaf development have progressed to solenostely and other complications.

B. *Leaves.*

A two-sided wedge-shaped apical cell forming two rows of segments is the type for the leaf of both forms. This is shown in Text-fig. 9 (*L. linearis*). The outer divisions of the segments are the marginal cells which give rise to the pinnae of the leaf; the other segments are mainly formative of the petiole. As each pinna corresponds to a segment of the apical cell, it follows that they alternate on opposite sides of the rachis. The leaf first makes its appearance as a blunt conical emergence, but as the leaf grows it assumes the form of a flattened cone with a broad base, more convex on the outer side and very soon showing circinate vernation.

1. *Petiole.*—The minute anatomy of the petiole of *L. microphylla* and *L. linearis* is practically identical. The transverse section is circular to oval in outline (Text-figs. 10-11). The cortex is composed of very large, thin-walled cells, particularly large in *L. linearis*, in which intercellular spaces are absent. Two or three layers of sclerenchyma occur on the outer limits.

The centre is occupied by a single vascular strand, subrotund in outline. The petiolar bundle is concentric and contains a xylem strand, ∩-shaped in *L. microphylla* (Text-fig. 12), the arms of the ∩ being very thick, and ∧-shaped in *L. linearis* (Text-fig. 13), the bases being directed towards the apex of the stem. The metaxylem elements in *L. linearis* are few in number but very large, in some instances the arms of the ∧ being occupied by a single row of tracheids. These large tracheids have scalariform thickening laid down on their walls.

Immediately one end of the leaf trace becomes separated from the stem stele, protoxylem groups make their appearance in the bundle which had hitherto been without them; these protoxylem groups being three in number. Two are placed on the ends of the arms of the xylem, appearing when the ends become separated from the stem bundle; consequently one appears before the other. The third group is placed at the apex and its position is variable in the two species. In *L. microphylla* it was observed in all positions intermediate between endarchy and exarchy, primarily endarch but finally it forms the connection between the two arms of the ∩. In *L. linearis*, on the other hand, this third protoxylem group is always exarch, appearing in that position from the first in the leaf trace. It often, in section, has the appearance of being squeezed out by the large metaxylem elements.

The three protoxylem groups in the Polypodiaceae are considered as being primarily endarch. A somewhat similar transition of the median protoxylem group from an endarch to an exarch position was described by Marsh and confirmed by the writer (1924) in various species of *Cheilanthes*.

Here the movement of this protoxylem group may be traced at different levels of the petiole till it becomes exarch in position, and finally, in *Cheilanthes fendleri* and *Ch. tenuifolia*, becomes completely detached from the main mass of metaxylem elements, and is broken up into three or four smaller groups.

Bertrand and Cornaille (1902, p. 99) considered that the trace with three protoxylem groups resulted from the fusion of two binary chains (the latter

term being employed for the trace with two protoxylem groups) and the reduction of the median bipolar group thus formed to a minimum. Both of these forms have been derived in their turn from more complicated types.

Gwynne-Vaughan (1903, p. 722) has objected, however, that hardly any evidence can be brought forward to support this theory of reduction. The facts rather seem to the writer to present a series in the progression of the leaf trace. The movement of this median protoxylem from the endarch to the exarch position causes a break in the continuity of the metaxylem elements which appear to die out at this level. The protoxylem comes to form the only connection between two distinct metaxylem masses, and by the splitting of this protoxylem group in this position into two, there would be formed two xylem masses, each with two endarch protoxylem groups. Later, the phloem, pericycle and endodermis might follow this; thus two bundles would be present in the petiole. These in their turn, by further division, would give rise to more complicated types.

The phloem of the bundle in the forms under consideration is separated from the xylem by a single layer of parenchyma. It consists of two rows of sieve tubes which surround the xylem without any interruption in their continuity. The sieve tubes are of uniform size and represent the metaphloem. Protophloem is not represented in either type. This is surrounded by the pericycle which is several layers deep. The whole is encircled by the endodermis. When the

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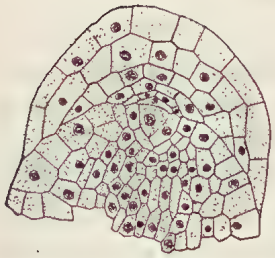
Text-figs. 16-34.

16. A longitudinal section of the root apex in *Lindsaya microphylla*. × 200.
17. A transverse section of the root apex of *L. linearis* showing the apical cell and its segmentations. × 200.
18. A transverse section of the root of *L. linearis*. × 45.
19. A transverse section of the root bundle of *L. linearis* showing its diarch nature. The xylem is surrounded by phloem, pericycle and endodermis. × 200.
20. A transverse section of the root bundle of *Lindsaya microphylla*. × 200.
21. A cortical cell of the root of *L. linearis*, showing the septate branching and multinucleate nature of the fungus infecting it. The nucleus of the host is well developed. × 450.
22. A longitudinal section of the pinnule of *L. microphylla* in the region of the sorus showing the nature of the indusium and the receptacle deflected towards the lower surface. × 45.
23. A longitudinal section of the young sporangium of *L. microphylla* showing the basal cell and the sporangial cell proper. × 200.
24. A longitudinal section of a later stage in the development showing the central cell which has cut off the wall cells and the three rows of cells in the stalk. × 200.
25. The central cell is here cutting off the tapetum. × 200.
26. At this stage of development the archeosporium has divided into four cells, the spore mother cells. × 200.
27. A longitudinal section of the sporangium showing the disintegrated tapetal cells. The spore mother cells have enlarged, separated and become rounded. × 200.
28. A transverse section of a spore mother cell showing the chromosomes after synapsis. × 450.
29. A section of a spindle formed during the division of the spore mother nucleus, showing three of the four poles which are sometimes formed. × 450.
30. A mitotic spindle formed during the nuclear division of a cell of the petiole tip of *L. microphylla*, showing the large number of chromosomes present. × 450.
31. A mitotic spindle formed during the nuclear division of the spore mother cell of *L. microphylla* showing the reduced number of chromosomes. × 450.
32. This indicates the typical arrangement of the spores formed from the division of the spore mother cells of *L. microphylla*. × 200.
33. The spores of *L. linearis*. × 200.
34. The spores of *L. microphylla*. × 200.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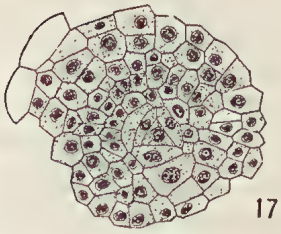
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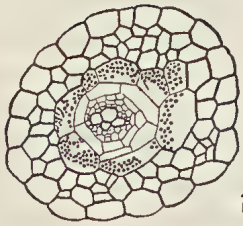
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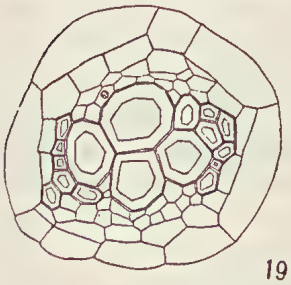
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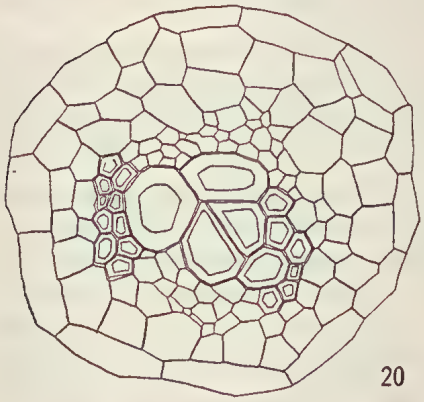
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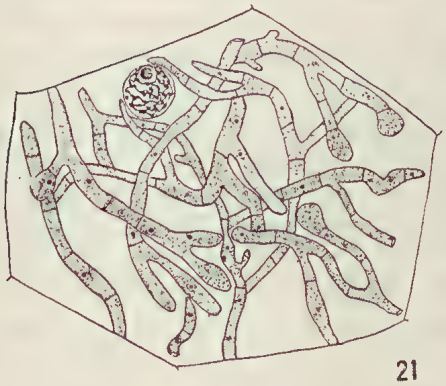
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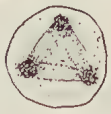
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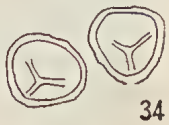
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petiole reaches the level of the pinnae, branches are given off from the petiolar bundle, which constitute the vascular supply to the rachis.

It is perhaps worthy of note that very occasionally the writer has observed, in *L. microphylla*, the petiole itself branching dichotomously.

2. *Pinnules.*—In both types the barren pinnules are frequently lobed. The veins show a very regular dichotomous branching. The pinnules of *L. linearis* are of a much deeper green colour than those of *L. microphylla.*

The cells of the upper and lower epidermis are large and have a very thick cuticle. The stomata are confined to the lower surface of the leaf and open into large air cavities (Text-fig. 14). The pinnule in both types is characterized by the absence of palisade tissue, the whole of the tissue between the two epidermes being composed of parenchyma with large intercellular spaces. The cells of this mesophyll contain very large chloroplasts which are distributed fairly evenly around the margins of their walls. The absence of palisade tissue and the arrangement of the chloroplasts probably bear relation to the light intensity. The vascular bundle of the pinnule is usually collateral. It is surrounded by endodermis, composed of large thin-walled cells. This encloses a mass of tracheids representing the xylem surrounded by parenchyma with a few sieve tubes.

C. *Roots.*

The roots arise in connection with the bases of the leaves. The primary roots branch profusely; the branches arise in two lines, corresponding to protoxylem groups in the vascular bundle of the primary root.

Text-figures 15, 16, 17 indicate that the apex of the root of both ferns is characterized by the presence of a three-sided pyramidal apical cell, from the sides of which segments are cut off in regular succession. The formation of the body of the root and the root cap may be traced to definite segments of the apical cell.

The cortex is two or three cell layers deep and very quickly becomes sclerized (Text-fig. 18). The vascular bundle of the root is surrounded by the endodermis which is not always to be observed in the older portions (Text-figs. 19-20). The root is diarch; xylem is composed of protoxylem and metaxylem; the elements of the latter are large and have scalariform thickening laid down on their walls. The phloem is well developed and is separated from the xylem by a layer of parenchyma. It does not, however, extend round beyond the protoxylem groups where xylem and pericycle are in contact. There is a multilayered pericycle, the cells of which are large and often have a great deal of starch stored within them.

A curious feature of the root in both forms is that fungal hyphae appear in the cortical cells a little behind the apex (Text-fig. 21), indicating the presence of mycorhiza in the roots. The cortical cells in which the fungus is present are large and have thin walls. Fungal hyphae were observed passing through the walls from one cell to another. The fungus is a branching, septate, multinucleate form. The ends of the branches are often swollen. Fungal sporangia were also observed in the cells. No root nodules are visible externally, so that the presence of the fungus evidently does not stimulate the plant to form new tissues. Symbiosis was observed to be a constant feature in the root, no matter from what situation the plant was collected.

Mycorhiza have been recorded from other parts of the Pteridophyta. Laing (1899) describes an endophytic fungus present in the prothallus of *Lycopodium clavatum.* In 1917, Lawson found the same in the prothalli of *Tmesipteris* and *Psilotum.*

D. *Sorus.*

The sporophylls are usually not lobed, but are often rolled inwards, affording protection for the sori. The latter are borne on the ends of the veins which are linked together distally to form a continuous vascular commissure. The sporangia have followed this extension of the vascular supply and thus the fusion sorus has arisen. This is characteristic of the genus.

The tracheids composing the vascular commissure to the sporangia are of a different nature from those present in the ordinary veins of the leaf. Those of the vascular commissure are shorter, broader and of the nature of storage tracheids. This has also been described by Bower (1914) as occurring in connection with the fusion sorus of the Blechnum type.

The nature of the sorus, indusium and receptacle, and their early development in *Lindsaya linearis* have been carefully investigated and described by Bower (1918, pp. 14-15). The marginal cells, as in *Dicksonia*, become the apex of the receptacle by segmentation; the two indusial flaps originate intramarginally, as in *Dicksonia*, differing in bulk, the inner (abaxial) being thinner while the receptacle is deflected towards the lower surface. The sporangia at first show a gradate sequence, but later this is not strictly maintained, and young sporangia become interpolated between the older, leading to the typical mixed condition. These facts are also true for *L. microphylla*, as indicated in Text-fig. 22.

The sporangia develop in the manner typical for Leptosporangiate Ferns. One of the cells forming the wall of the receptacle enlarges and is cut off by a transverse wall into a basal cell which undergoes no further division, and an upper cell which forms the sporangium proper (Text-fig. 23). The upper cell undergoes divisions which result in the formation of a pyramidal apical cell from which various segments are cut off, giving rise to the three rows of cells seen in the stalk. These undergo no further longitudinal divisions. The upper part of the sporangium enlarges and a periclinal wall is formed in the apical cell. Thus the wall cells are cut off, and remain permanently one layer thick (Text-fig. 24).

The central cell of the sporangium cuts off a single layered tapetum by further division (Text-fig. 25), and this, later by a further periclinal division, becomes double.

The archeosporium develops up to the quadrant stage (Text-fig. 26), but often undergoes no further development in *L. microphylla*, so that there are usually only four spore mother cells, although occasionally six are present. In *L. linearis*, however, there are frequently eight spore mother cells developed.

As the subsequent development is the same in both types, in order to avoid unnecessary duplication, the following description and text-figures will be taken from *L. microphylla*. As soon as the spore mother cells are formed, the tapetum begins to disintegrate, the spore mother cells separate, and become rounded and very much larger (Text-fig. 27). The nuclei of these cells enlarge considerably until they become almost as large as the cell itself, leaving a very thin selvage of protoplasm around the wall. The linin network of the nucleus at this time becomes very distinct.

After the complete disintegration of the tapetal cells, the nucleus prepares for division. It undergoes the typical stages associated with reduction division, chromosomes are formed (Text-fig. 28) and finally a spindle is produced. The chromosomes pass to the poles of the spindle, and two nuclei are produced. These nuclei undergo another division differing from the former in that it is homotypic

in nature. Thus four nuclei, and finally four spores are produced from each spore mother cell, the tetrad having the typical arrangement indicated in Text-figure 32.

It frequently happens that the second division occurs so rapidly after the first that a spindle with four poles is produced (Text-fig. 29). The number of chromosomes present is the same as that found associated with the second division. This is frequently found in the division of the spore mother cell of the Filicales.

Text-figure 30 represents a mitotic spindle observed in a petiole tip. Here the number of chromosomes present was counted as being from 32 to 40. In the second division of the spore mother nucleus only 16 chromosomes are present (Text-fig. 31).

The wall becomes organized into various parts (annulus, etc.). This has been described and figured by Bower for *L. linearis* (1918, p. 16, fig. 14).

After the division of the spore mother cell, the four spores are enclosed within the mother membrane. This disintegrates and the spores become separated, their walls undergoing various modifications. The outer wall becomes very thick, and spiny. The form of the spore in both cases is tetrahedral (Text-figs. 33-34).

The number of spores present in *L. microphylla*, by actual count, was 16-24, in *L. linearis* 24-32. The latter confirms the estimate made by Bower.

Bower (1918) considers that the marginal origin of the receptacle in such types as *Lindsaya* and *Dicksonia*, etc., where it becomes downward-directed as development proceeds, illustrates how the initial steps in the modification to a superficial sorus may be actually observed in the ontogeny of the typical Marginales.

Conclusion.

The view which is universally supported at the present day, is that *Lindsaya* is a genus anatomically primitive, but possessing other characters which are more advanced.

Its affinities, as determined by anatomical structure and soral character, are with the Davallieae. The soral characters also indicate relationship with the Dicksonieae, except that as the sorus becomes older it assumes a "mixed" character. Thus the sorus is more advanced than that of the Dicksonieae, although the anatomical structure is very much more primitive. In respect to its anatomical structure, then, *Lindsaya* takes a lower place than any of the Dicksonoid series.

The mature stelar structure is regarded as furnishing a phylogenetic link between the protostele and the solenostele. These are regarded as primitive types of vascular arrangement in the Polypodiaceae. Gwynne-Vaughan (1903, p. 732) remarks that these primitive characters do not run parallel with Bower's division of the order into Gradatae and Mixtae.

Bower, however, supports the view that there are several lines of descent among the Polypodiaceae alone, and a primitive type of vascular arrangement might occur in the primitive members of each line of descent. He considers that in *Lindsaya* no structural advance was made to complete solenostely, owing to the restricted size of the species of the genus which made distension of the stele unnecessary.

It seems that the convergence of evidence from many forms, indicates that anatomical structure and soral characters have not necessarily advanced together in the progressive development of the Filicales, that one or other might have advanced while the other remained stationary; that is, these characters have taken quite independent courses of evolution. Factors influencing one have not necessarily made themselves felt upon the other.

Since the structure of the rhizome of *Lindsaya* is constant in so many species, it has been suggested that it forms a good generic character.

Summary.

1. Apex of the stem in both types is occupied by a tetrahedral apical cell.
2. The stem anatomy of *Lindsaya linearis* and *L. microphylla* coincides with the "Lindsaya-type". The "internal pocket" of phloem is due to change in procambial destination of cells.
3. The leaf trace departs as a single strand from the dorsal arch in much the same manner as described by Tansley and Lulham, except that no internal endodermis appears.
4. Apices of the leaves are occupied by a two-sided wedge-shaped apical cell forming two rows of segments.
5. Petiolar bundle forms a single strand containing three protoxylem groups, two of which are endarch in position, the third (medium) group in *L. linearis* exarch, but in *L. microphylla* occupying positions intermediate between endarchy and exarchy.
6. Stomata are confined to the lower surface of the pinnule. Cuticle thick. No palisade tissue present.
7. Apices of root occupied by a three-sided apical cell.
8. Roots are diarch.
9. Symbiosis occurs in the roots of both forms, fungal hyphae causing the infection being septate and branching and multinucleate.
10. Sorus is marginal in origin; true indusium is present; sorus is mixed in character.
11. Tracheids composing the vascular commissures are of a different nature from those of the ordinary veins of the pinnule.
12. In *L. microphylla*, 4-6 spore mother cells are formed, in *L. linearis*, usually 8.
13. Sorus of *Lindsaya* indicates how the initial steps in the ontogeny of the superfilicales may have occurred.
14. Nearest affinities of the Lindsayas are the Davallieae.

In conclusion I wish to thank Professor Lawson, in whose laboratory the investigation was carried out, for advice and guidance; also Dr. McLuckie and Mr. Brough for helpful criticism.

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THE DEVELOPMENT OF TWO AUSTRALIAN SPONGE-CRABS.

By Herbert M. Hale, Zoologist (Crustacea), South Australian Museum.
(*Contribution from the South Australian Museum.*)

(Plates xxxix-xl, and five Text-figures.)

[Read 25th November, 1925.]

It has been often stated that all marine Brachyura hatch as Zoeae, and pass through two or more pelagic larval stages before reaching the adult form. In 1914, however, Miss Rathbun recorded a female of *Paranaxia serpulifera* from the Monte Bello Islands, Western Australia, with "young crabs in the adult state" beneath the pleon; she remarks that juveniles in two stages thus accompany the mother "but whether the first is hatched directly from the egg or not, it is impossible to tell"; both young stages are figured by Rathbun. The complete life-history of the majority of marine crabs is unknown, and Rathbun (1918), bearing in mind the case of the Spider-crab from Australia, later pertinently remarks, "It is unwise to draw sweeping conclusions from a few cases".

In 1922, Montgomery described some well developed young taken from beneath the pleon of an Australian Dromiid crab (*Paradromia lateralis*), and states that, apart from Rathbun's Oxyrhynch, "this is the only other available record of such a case among marine Brachyura". Indication that some Australian Sponge-crabs do not have pelagic larval stages is to be found, however, in a paper by Haacke (1885), who suggested that the free-swimming larvae of sponges and Tunicates lodge on the carapaces of the young crabs sheltering under the abdomen of their parents, and that each member of a brood thus acquires its cloak from the mantle of its mother. The title of Haacke's paper does not indicate that these juvenile crabs are mentioned by him, and he does not remark upon their presence beneath the pleon as unusual; further, the names of the Dromiids concerned are not given.

Haacke states that he examined pea-sized Dromiids which had the sponge-cloak firmly fastened to the carapace (and not merely held in position with the posterior chelipeds) so that the crabs could not be robbed of their covering without injury. He then concludes that, as stated above, the cloak is possibly acquired very early in life, and that as a result of this probable "erblicher Symbioses", there is a tendency for different Dromiid species to have special species of sponges and Ascidians.

There are before me an adult female of *Cryptodromia octodentata* with young beneath the abdomen, and several specimens of *Paradromia lateralis* likewise burdened. The ova of these two species, as is usual with crustaceans which have a "direct" development, are relatively large; this is also the case with a third Australian Sponge-crab—*Platydromia thomsoni*—and leads one to suspect that this species likewise hatches at an advanced stage. The metamorphosis is apparently almost completely suppressed in *Paradromia lateralis* and *Cryptodromia*

octodentata, and possibly in *Paranaxia serpulifer* also; it must be remarked, however, that the pleopods of the juveniles of the two Sponge-crabs are very similar to the natatory abdominal appendages of the Megalopas of some other crabs.

Cryptodromia octodentata Haswell.

Cryptodromia octodentata is one of the largest of the Australian Sponge-crabs, the carapace of some specimens attaining a width of 85 mm. The cloak is usually a sponge or, more rarely, a mass of Ascidians, but sometimes other objects are held over the carapace. A specimen recently observed was using a piece of kelp weed as a shield and the ovigerous female illustrated on Plate xl is sheltered by the valve of a Fan-shell (*Pecten medius*); this shell admirably fits the back of the crab, and portion of it is so conveniently broken as to enable the crustacean to grip the inner edges of the chipped part with the hind chelae and so hold the mask firmly in position. An old example, 74 mm. in width, holds no shield on the back, but the carapace is considerably eroded and attached to it is an assortment of marine growths, including two species of plants.

The pleon of the adult female, with the aid of the exopods of the pleopods, forms a veritable pouch for the retention of the ova and later, as it proves, for the little crabs. In large examples the abdomen is half as wide as the carapace and, if it be closely adpressed, its tip overlaps the basal fourth of the outer maxillipeds; thus, when the tip is placed in its normal position between the anterior edges of the coxae of the large chelipeds, the greater part of the pleon stands away 10 mm. or so from the body. In specimens which bear a large mass of eggs, the abdomen is naturally forced far out of its usual position, but the contents of the apron are prevented from falling out by the large, flattened exopods of the second to fifth pleopods (Text-fig. 5*b*); the outer rami of these appendages are densely fringed with outstanding hairs, and are so shaped that, when pushed outwards by the eggs or young, they overlap and form perfect side walls to the brood pouch. The ova of some dried examples are more than 1mm. in diameter but were probably larger in life, for Rathbun (1923) states that "The eggs are very large and numerous, being 2 mm. in breadth"; the ova are attached to the long hairs of the slender, two-jointed endopods of the pleopods.

As previously mentioned, one female (preserved in alcohol) has a number of juveniles under the pleon; in this case the capacity of the brood pouch is strained to the utmost, for the well developed family consists of five hundred and thirty individuals (Pl. xxxix). The pleon and the exopods of the pleopods are forced far out from the body to accommodate the young crabs, some of which have the legs clasped around the hairs of the endopods of the pleopods. A description of these juveniles, and notes concerning a few of the succeeding stages, are given below.

Brood Young. Text-figs. 1*a* to 1*f*.

Colour completely bleached. Exoskeleton thin. Carapace very convex, about one-fourth longer than greatest width, the surface smooth and clothed with

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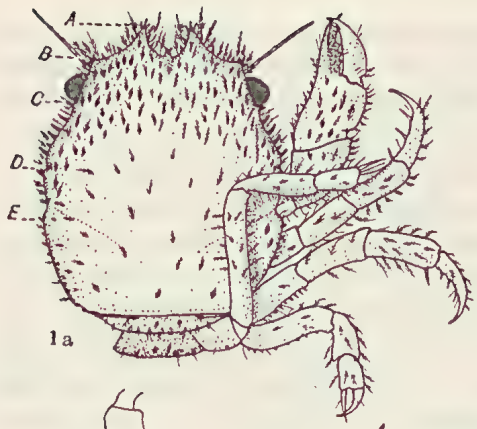
Text-figs. 1-5.—*Cryptodromia octodentata* Haswell.

1. Brood young; 1*a* and 1*b*, dorsal and ventral views (× 12 diams.); 1*c* and 1*d*, first and second antennae (× 33 diams.); 1*e*, pleon (× 21½ diams.); 1*f*, pleopod of fifth segment (× 53 diams.).
2. Carapace of young example 6.9 mm. in width (× 5 diams.).
3. Carapace of young example 15 mm. in width (× 2½ diams.).
4. Carapace of half-grown example 29 mm. in width (× 1.4 diams).
5. Adult female; 5*a*, carapace (× 0.9); 5*b*, pleopod of fifth segment (× 1.9 diams.).



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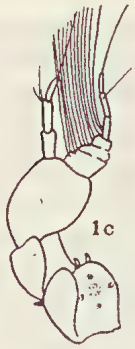

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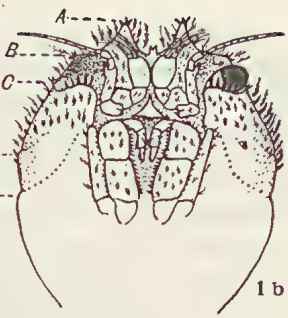

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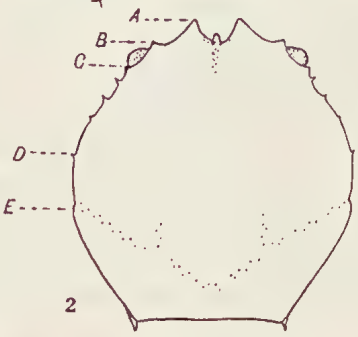

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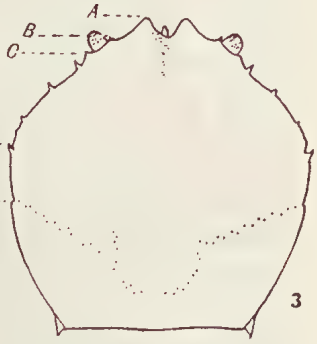

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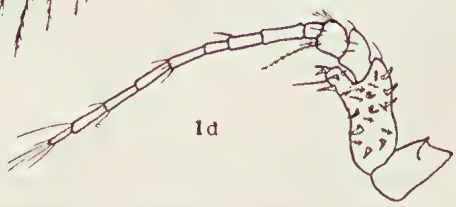

1d

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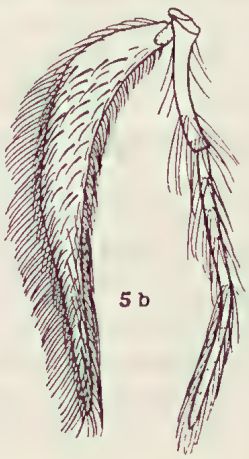
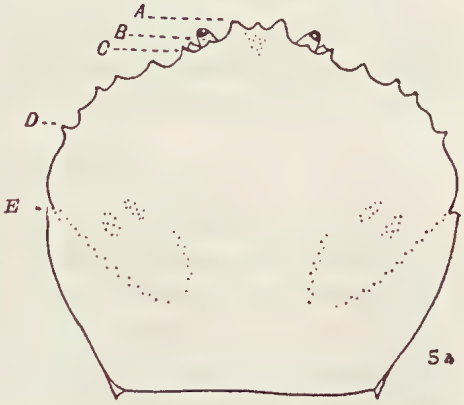
1e



5b



5a

moderately long hairs, which are plumose for their whole length; the hairs are sparse on the posterior two-thirds of the dorsum. Branchial (or cervical) groove not very distinct. Front cut into three teeth, the median projection small, downbent and apically bifid; each of the outer teeth (Text-figs. 1*a* and 1*b*, *A*) is capped with three or four short, stout spines and has plumose hairs and a few spines on the margins. A strongly marked angle (the supraorbital tooth) at about the middle of the orbit bears three spines (Text-figs. 1*a* and 1*b*, *B*). The outer, or posterior, angle of the orbit is slightly prominent and bears two or three spines (Text-figs. 1*a* and 1*b*, *C*). The anterolateral borders are provided with five to seven spines and with plumose hairs, and are a little incised at about two-thirds of their length (Text-figs. 1*a* and 1*b*, *D*), the incision followed by a slight protuberance which bears the last spine or two of the anterolateral series. The posterolateral margins are slightly convex and convergent, furnished anteriorly with a few spines and plumose hairs; there is a projection of the margin immediately behind the branchial groove (Text-figs. 1*a* and 1*b*, *E*).

Suborbital lobe armed with five or six spines; no notch in the orbital margin below the outer angle. Subhepatic region very slightly swollen.

First antennae (Text-fig. 1*c*) with peduncle stout, three-jointed; with two flagella, the inner of which is short, slender and composed of three articles, while the outer lash consists of six articles (the basal three stout) and is furnished with a dense brush of long hairs. Peduncle of second antennae four-jointed (Text-fig. 1*d*); second article furnished with spines and a few plumose setae; with inner angle slightly produced and with outer apical part strongly forwardly produced and lobular; flagellum rather long, composed of nine articles.

Eyes large. Margins of ischium and merus of third maxillipeds furnished with short, stout spines.

Chelipeds and legs much as in adult, armed with some marginal spines, with slender, plumose setae and (near apices) with a few simple setae; serrations of fingers of large chelae coarse.

Pleon bent under body, narrow, seven-segmentate, furnished with plumose hairs and a few short spines; apex of telson slightly incised; third to fifth segments with one spine, and sixth with two spines, at each posterolateral angle (Text-fig. 1*e*). Pleopods of second to fifth segments stout, long, each with protopod large and more than half as long as exopod, which is flattened and provided with sixteen long, plumose hairs on the margins; endopod rudimentary, unjointed, not much more than one-third as long as exopod and with apex furnished with four minute hooks (Text-fig. 1*f*); the apex of the exopod of the last pair of pleopods reaches to level of three-fourths of length of telson, and the fringing hairs extend well beyond apex of pleon.

Length of carapace, 2.8 mm.; width of carapace, 2.2 mm.

Growth Changes. Text-figs. 2-5.

There is also before me a series of examples of various sizes, most of the small specimens being preserved in a dry state.

The smallest member of this series is 4.8 mm. in length and 4.1 mm. in width, and differs from the brood young in the following particulars: The carapace is relatively slightly wider at about the middle of its length and the front is relatively a little narrower. The median tooth is very obscurely subbifid, is bent downwards and slightly forwards, and bears a few small lateral spines. Many of the marginal spines persist, but are very tiny. The posterior (outer) angle of

the orbit is more prominent, and below it is a small V-shaped notch. The supra-orbital tooth is more acute. The suborbital lobe bears tiny spines and the inner angle is acute. The anteroexternal angle of the buccal cavern is somewhat acute and behind it is a slight projection. Four tiny spiniform projections have developed on the anterolateral margins; the first has two spines on its anterior slope, the third is minute, and the fourth is just behind the incision (*D* in the figures) which is very much less distinct than in the brood young. The clothing (which is mostly denuded) is of the same character, but the hairs are relatively smaller. The apex of the pleon is narrowly rounded.

It has been determined that in some other Decapods the general increase in size after a moult amounts to roughly one-sixth, so that if we venture here to apply an approximate rate of growth, this specimen, since attaining the size of the brood young, has passed four, or at most five, ecdyses.

The next example is 7.8 mm. in length and 6.9 mm. in width (Text-fig. 2); thus, in proportion, the carapace is again wider and the front narrower. The median projection is simple and is still more forwardly directed. The suborbital lobe bears a few tiny spines and the inner angle is dentiform. The first of the small anterolateral teeth has three minute spines on its anterior slope. The clothing of the dorsum is denuded, but that of the subbranchial regions consists of slender hairs, sparsely plumose for their whole length, and that of the anterior parts of the under surface of short and densely plumose hairs.

A specimen 15.5 mm. in length is 15 mm. in width. The median frontal projection is nearly horizontal. The suborbital lobe bears no tiny marginal spines. The anteroexternal angle of the buccal cavern is spiniform and the projection near it is conical. The first of the four teeth of the anterolateral margins is larger than the others, and immediately in advance of the fourth is a very slight protuberance. The dorsum is densely clothed with erect setae, each of which is provided with tiny lateral spikelets, the lastnamed being largest on the apical half. The subbranchial regions bear thin and very sparsely plumose hairs.

The carapace of individuals 29-30 mm. in length (Text-fig. 4) is as wide as long. The projection or tubercle just in advance of the last tooth of the anterolateral series is usually moderately prominent, and near it there is sometimes an additional low tumidity on the dorsum of the carapace. The clothing consists of setae which have a brush of lateral setae on their distal half and others (more particularly on the legs) which have lateral spikelets for almost their whole length.

The female with brood is 50 mm. in length and 53 mm. in width (Text-fig. 5*a*); comparing this individual with the juveniles it is now evident that the following changes occur during growth. At each moult the carapace grows relatively wider behind the level of the orbits and relatively smaller in front of this level, so that, while the distance between the hinder angles of the orbits is more than three-fourths of the width of the carapace in the young, it is not much more than one-third of the width in the mature female. Thus that part of the anterolateral margins in front of the incision (*D*) gradually becomes more oblique and the portions posterior to the notch (which at first slope outwards) eventually converge. At an early period the tiny marginal spines disappear and four dentiform projections appear on the anterolateral margins while, later, a fifth tubercle (more or less distinct) is developed, very close to the incision (*D*) which then resembles the interspaces between the other teeth. The projection of the margin below the branchial groove assumes a more or less dentiform or lobular character. The

supraorbital tooth gradually becomes relatively smaller and the outer angle of the orbit more prominent, while a notch appears in the orbit below this angle; the inner angle of the orbit becomes spiniform. A conical tooth develops below the anteroexternal angle of the buccal cavern, which also becomes spiniform. The tumidity on the subhepatic region is accentuated. The clothing changes in character and is finally very dense. The serrations of the fingers of the large chelipeds increase in number, and small tubercles take the place of tiny marginal spines. Additional articles are gradually developed in the flagella of the antennae. The basal article of the peduncle of the first pair is now relatively stouter and the third thinner than in the young; the slender inner lash consists of fourteen articles and the tapering outer flagellum of thirty-two articles, with a dense brush of hairs. Both inner and outer distal angles of the second article of the second antennae are produced and the flagellum contains forty-two articles. In the female the abdomen increases in width. The pleopods change entirely; it is probable that the four pairs of immature abdominal appendages atrophy at an early stage, and that the permanent pleopods of both sexes then develop. Hyman (1920) shows that this happens in *Uca pugilator*.

It has been noted above that the species attains a width of 85 mm. It is evident that the relative widening of the carapace at each moult obtains throughout the life of the animal, for in very large examples the carapace is approximately one-sixth wider than long. In aged specimens the chelipeds, particularly in the males, are very strong, with the serrations of the fingers blunt, and the marginal tubercles are often spiniform. The fourth projection of the anterolateral margins of the carapace may be acutely spiniform, as are the others. The projection behind the branchial groove is prominent, and a row of more or less conical teeth may develop on the posterolateral margin; traces of these posterolateral teeth are sometimes found in small examples. The branchial groove is usually deep and in two examples the cardiac region is well delineated.

All the specimens dealt with above were taken in St. Vincent Gulf, South Australia.

Paradromia lateralis Gray. Plate xl, B.

The brood pouch of this species is much as in *Cryptodromia octodentata*; the pleon of an adult female, when closely folded against the sternum, reaches to the middle of the length of the outer maxillipeds. The ova are large, an advanced egg taken from a female 17 mm. in width being 1.14 mm. in length and 1 mm. in width; Henderson (1888) records an ovigerous female from Bass Strait.

I am much indebted to Mr. Melbourne Ward for a female of *Paradromia lateralis*, 14 mm. in width, with young in the apron; this specimen was recently secured "On reef at Shelly Beach, Manly, New South Wales; on sand under stones below low tide." Several dried examples from St. Vincent Gulf also have young in the brood pouch and in one case juveniles in two stages are present.

Brood Young, 1.

The little crabs in the earlier stage are very soft, and when relaxed have the appearance of being ready to moult. They are only one-third larger than the ripe ova, being approximately 1.5 mm. to 1.6 mm. in length and 1.15 mm. to 1.25 mm. in width. The pleon is somewhat loosely flexed; the pleopods of the second to fifth segments are much as in the next stage, each having a long protopod, a long flattened and hair-fringed exopod and a short endopod with minute apical hooks.

These examples, judging from their dimensions, are representatives of the stage described by Montgomery (1922), but their condition is too poor to warrant further description here. The peraeopods are moderately stout and the lastnamed author treats this stage as "definitely post-larval", although the pleopods are certainly not "similar to those of the adult" as he states. It is strange that the sedentary young of this species and of *Cryptodromia octodentata* should retain pleopods well developed for swimming.

Brood Young, 2. Plate xl, B, figs. 1*a* to 1*f*.

The young of the next stage are about one-fourth larger than those of the preceding (the proportionate increase is greater in Rathbun's Oxyrhynch, namely, "more than one-half"). About twenty examples of this instar are contained in the pleon of the female collected by Mr. Ward, and the following description is based upon these fresh specimens:—

Colour olivaceous-brown. Exoskeleton thin. Carapace very convex, not much longer than greatest width; dorsum furnished with short spines intermixed with setae which are shortly and sparsely plumose; regions moderately well defined and branchial groove distinct. Front a little downbent, with three teeth, the median of which is armed with three spines on each lateral margin; lateral margins of outer teeth with stout spines and setae similar to those of dorsum, and apices capped with three to four spines (Pl. xl, fig. 1*a*, *A*). A large supra-orbital tooth (Pl. xl, fig. 1*a*, *B*) at the middle of the length of the orbit bears three apical spines, and between it and the posterior angle of the orbit is an inconspicuous projection armed with two spines. Posterior margin of orbit bent abruptly outwards and furnished with a spine; hindermost point of orbit (Pl. xl, fig. 1*a*, *C*) not prominent, but margin of carapace immediately beyond this point curved backwards, thus forming a somewhat rounded projection (Pl. xl, fig. 1*a*, *D*) which is furnished with about five spines. Behind this is another prominent protuberance of the lateral margins (Pl. xl, fig. 1*a*, *E*). Posterolateral margins a little sinuate and slightly convergent, provided with a few spines and setae; there is a projection immediately behind the branchial groove (Pl. xl, fig. 1*a*, *F*).

Suborbital lobe armed with five or six spines. A short, stout spine and several smaller spines on subhepatic region, very close to posterior angle of orbit.

First antennae (Pl. xl, fig. 1*b*) with two flagella; peduncle stout, three-jointed, furnished with a few spines; inner lash short, composed of three rather robust articles, and outer flagellum four-jointed (the three basal articles stout) and with a brush of long hairs. Peduncle of second antennae (Pl. xl, fig. 1*c*) four-jointed, armed with some short spines and a few setae; second article with inner apical angle a little produced, and outer apical part prominently forwardly produced and lobular; flagellum slender, composed of eight articles.

Eyes large. Margins of ischium and merus of outer maxillipeds with short spines. Chelipeds and legs stout, armed with short spines, simple setae, and sparsely plumose setae.

Pleon bent under thorax, narrow, seven-segmentate, surface furnished with short spines and setae (Pl. xl, fig. 1*d*); lateral margins of telson sinuate and posterior margin incised; tumid posterolateral margins of telson with short spines; second to fifth segments with a spine at each posterolateral angle. Pleopods of second to fifth segments long, each with protopod stout and nearly half as long as the exopod, which is flattened and bears fourteen plumose marginal hairs

on the apical half; endopod small, unjointed, scarcely more than one-third as long as exopod, and with four tiny hooks near apex (Pl. xl, fig. 1*f*). Uropods represented by a tiny subcordate rudiment on each side (Pl. xl, fig. 1*e*, *U*).

Length of carapace, 1.86 mm.; width of carapace, 1.7 mm.

Growth Changes. Plate xl, B, figs. 2 and 3.

In a specimen 5.6 mm. in width (Pl. xl, fig. 2) the carapace is a little wider than long and its margins still bear spines, which are, however, very tiny. The supraorbital tooth (*B*) is relatively smaller than in the brood young and the small projection of the supraorbital border has disappeared. The posterior angles of the orbit are prominent (*C*), there is a little notch below the angle, and the inner angle of the suborbital border is spiniform. The two projections of the anterolateral margins each end anteriorly in a tubercle (*D* and *E*). The regions of the carapace are not defined but the branchial groove is distinct. A small subhepatic tooth (*S*) is developed.

As in *Cryptodromia octodentata*, the carapace becomes relatively wider behind the level of the orbits, and relatively narrower from this level forwards, at each moult; thus the distance between the hinder angle of the orbit (*C*) and the apex of the first tubercle of the anterolateral margins (*D*) gradually increases. Montgomery suggests that either the supraorbital tooth of the young or, alternatively, the tiny projection just posterior to it, becomes the posterior angle of the orbit in the adult; it is not probable that the orbit thus changes its position, nor is such conclusion strengthened by a comparison with the stages of *Cryptodromia*. The subhepatic tooth is not apparent in the brood young, but evidently appears at an early stage. Other mature characters develop as in the preceding species. An adult female (Pl. xl, fig. 3*a*) has the carapace distinctly wider than long; the supraorbital tooth is much reduced and no more prominent than the outer angle of the orbit. The inner flagellum of the first antennae consists of nine articles, and the outer of twenty-three articles, while the lash of the second antennae is twenty-jointed. As in *Cryptodromia octodentata*, the pleopods change utterly (Pl. xl, fig. 1*f* and 3*b*).

PLATYDROMIA THOMSONI Fulton and Grant.

A female of this small species, dredged by Sir Joseph Verco in Investigator Strait, South Australia, is 11 mm. in width and bears a score of eggs each more than 1 mm. in diameter. The ova are thus considerably larger than those of some crabs which are known to hatch as Zoeae; for instance, the numerous eggs of a large female of *Carcinides maenas* are only 0.29 mm. to 0.3 mm. in diameter. It is therefore likely that the young of *Platydromia* do not emerge from the eggs as Zoeae, but hatch at a later stage of development.

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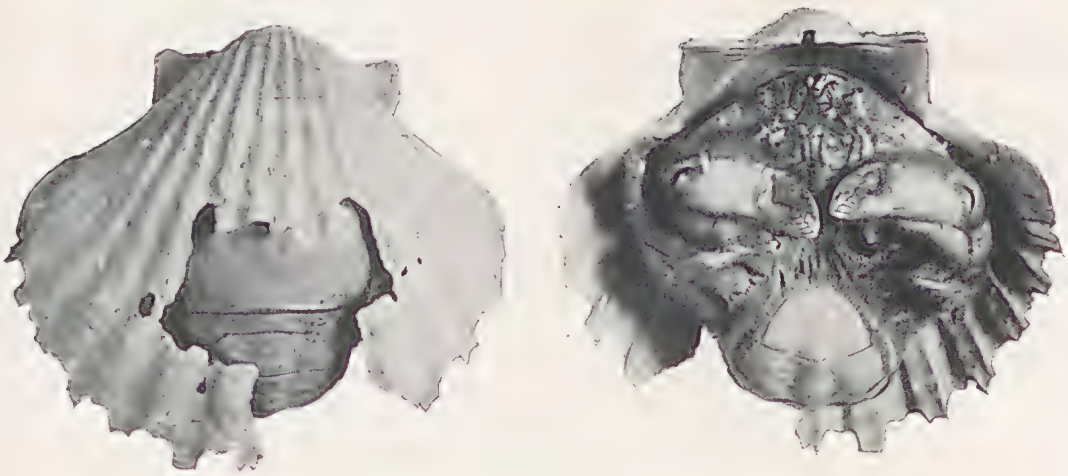
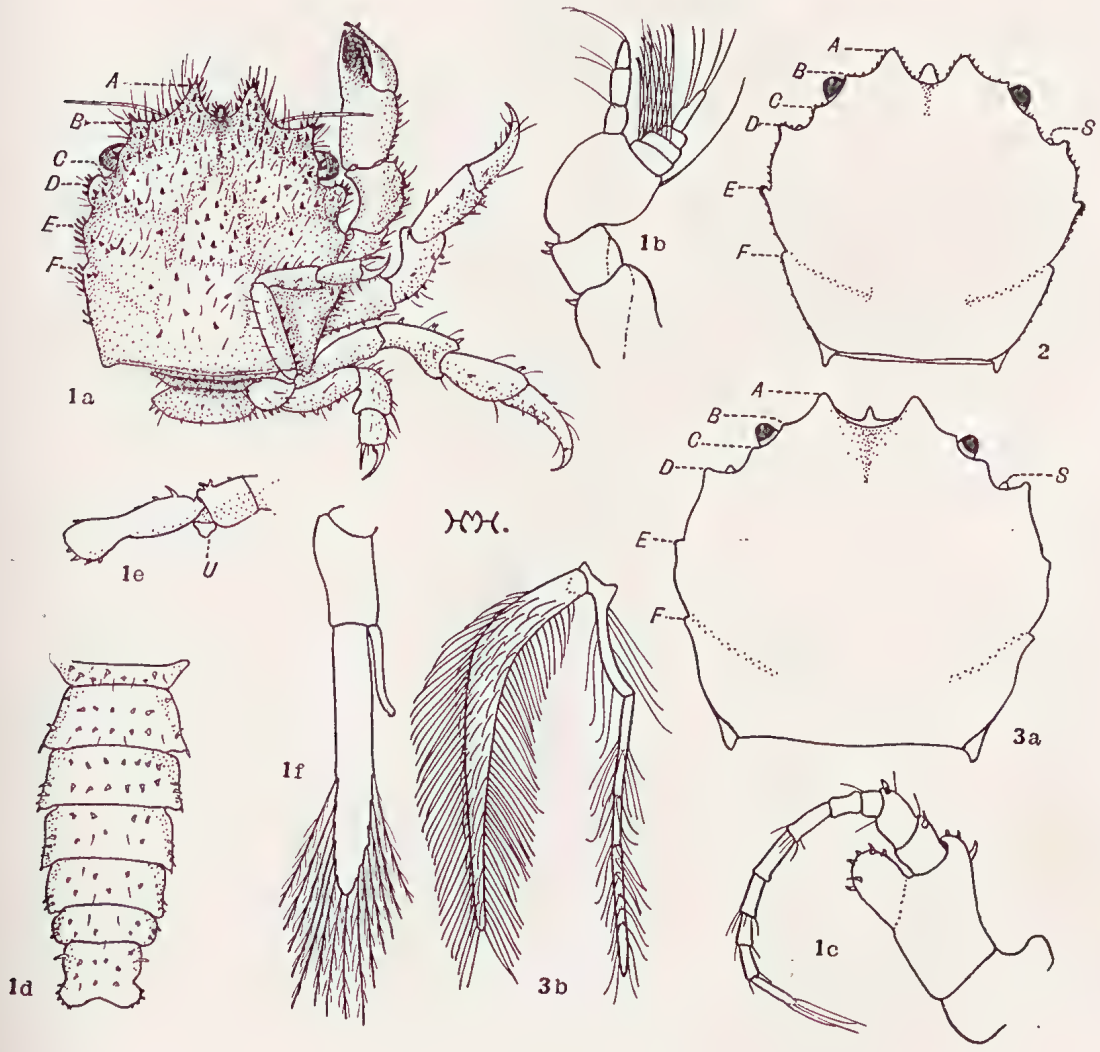
Cryptodromia octodentata.



A. Ovigerous female of *Cryptodromia octodentata.*



B. *Paradromia lateralis.*

EXPLANATION OF PLATES XXXIX-XL.

Plate xxxix.

Cryptodromia octodentata.—Female with young beneath the pleon; the sponge cloak of the mother is shown above (nat. size).

Plate xl.

A. Ovigerous female of *Cryptodromia octodentata* sheltering beneath the valve of a *Pecten* (¾ nat. size).

B. *Paradromia lateralis.*

Fig. 1. Brood young; 1*a* dorsal view (× 17 diams.); 1*b* and 1*c*, first and second antennae (× 57 diams.); 1*d*, pleon (× 22 diams.); 1*e*, lateral view of sixth and seventh segments of pleon (× 57 diams.); 1*f*, pleopod of second segment (× 57 diams.).

Fig. 2. Carapace of young example 5.6 mm. in width (× 6½ diams.).

Fig. 3. Adult female; 3*a*, carapace (× 3¾ diams.); 3*b*, pleopod of fifth segment (× 7 diams.).

DESCRIPTIONS OF NEW SPECIES OF AUSTRALIAN COLEOPTERA. Part xviii.

By Arthur M. Lea.

[Read 28th October, 1925.]

SCAPHIDIIDAE.

Scaphisoma politum Macl.

S. queenslandicum Blackb.

The types of *S. politum* agree well with some specimens that were compared and agreed with the types of *S. queenslandicum*.

HISTERIDAE.

Platysoma incongruum, n. sp.

Black, legs and antennae obscure reddish-brown.

Head with a transverse oblong, defined by impressed lines, and containing sharply defined but rather small punctures; clypeus with minute punctures. Prothorax about twice as wide as the median length, sides feebly rounded, but in front strongly rounded to the apical emargination, near each side with a wide and rather deep channel, each side in consequence appearing to have a fairly wide elevated margin, on the inner edge of which, part of the submarginal stria may be faintly traced; punctures small and irregular, becoming fairly large in parts of the sublateral channels and almost absent from the margins. Scutellum small and triangular. Elytra about one-fourth longer than wide, each with six well-defined dorsal striae, of which the second is not quite as long as the others; epipleurae each with three striae and some fairly distinct punctures. Propygidium and pygidium opaque, finely punctate and shagreened. Prosternum with two short striae between front coxae; chin piece wide and bilobed. Metasternum with a narrow median line; middle impunctate, but side-parts with distinct punctures of varying size and density. Abdomen with sides punctate and shagreened. Front tibiae with tarsal groove well defined, with three external teeth, of which one near the apex is separated from the others (one of which is very small) by a wide incurvature; middle and hind tibiae narrower and longer than the front ones, and with three or four small teeth. Length, 5.5 mm.

Hab.—Queensland: Cairns (E. Allen).

Although by Leconte and Horn's table this species would be referred to *Platysoma*, it certainly does not appear at first glance to belong to that genus, and probably a subgenus will be proposed for it, as was done for *P. extrarium*, an equally aberrant species. The type is probably a female; a second specimen (probably a male) agrees perfectly with it on the upper surface, but its prosternum has the striae conjoined at the base, and well defined to the base of the chin-piece (this unfortunately is broken in front), the median line of the metasternum is deeper, and is within a large, shallow, elliptic depression; its head was detached from the prothorax and is seen to have a deep notch on each side of the base on the upper surface, and a large round fovea on each side of the under surface, these being normally concealed.

NITIDULIDAE.

Circopes pictus, n. sp.

Reddish-brown, parts of upper surface and of pygidium black, prosternum, legs and antennae paler than metasternum and abdomen. Densely clothed with depressed pubescence, on part of elytra black, on rest of upper surface white and stramineous or ochreous, on under surface and legs whitish.

Head wide; labrum thin and shining. Antennae short, club briefly ovate. Prothorax rather strongly and evenly convex, greatest width (near the basal third) about thrice the median length, sides strongly rounded, hind angles embracing shoulders, apex less than half the width of base, emarginate for reception of head to about middle of eyes. Elytra at base narrower than base of prothorax, sides obliquely narrowed to apex, not covering pygidium. Intercoxal process of prosternum subtriangularly continued beyond coxae. Legs short and stout. Length, 2.25 mm.

Hab.—Queensland: Cairns (A. M. Lea). Type (unique), I. 12044.

Readily distinguished from all previously named Australian species by its beautiful clothing; on the upper surface this is so dense that the derm is normally concealed, but where it has been abraded or disarranged rather dense minute punctures may be seen. The derm of the prothorax has a large medio-basal dark blotch, the outlines of which are not traceable on the type; the greater portion of the elytra is black, the parts with pale pubescence being evidently paler than the other parts. On the elytra there is a large spot of ochreous pubescence, variegated with whitish, on the suture from the base to near the middle, and there are thin lines, spots, or individual white hairs on other parts of the elytra; the pygidium has black pubescence on the middle, whitish on the sides.

Brachypeplus xanthorrhoeae, n. sp.

Black, or blackish-piceous, elytra obscurely paler, muzzle, antennae, palpi and legs reddish. Upper surface (except of abdomen, which is minutely pubescent) glabrous.

Head subtriangular, a shallow depression on each side in front; punctures dense and sharply defined but rather small, becoming sparser and smaller in front. Prothorax flat except at sides, apex shallowly emarginate and slightly narrower than base, front angles rounded, hind ones rectangular; punctures as on head. Scutellum large, with small punctures. Elytra scarcely longer than wide; with series of punctures in narrow striae, interstices each with a distinct row of small punctures, but the sutural interstice with two rows of smaller ones towards base. Abdomen with punctures much as on head. Length, 3.25-4.25 mm.

Hab.—South Australia: Kangaroo Island (J. G. O. Tepper); New South Wales: Sydney (A. M. Lea).

A highly polished species, structurally fairly close to *B. basalis*, *B. Koebelei*, and several others of the genus, but upper surface almost entirely dark; from *B. planus* it is distinguished by its high polish and very different elytral sculpture. Numerous specimens were taken from closely compacted young leaves of species of *Xanthorrhoea*.

Brachypeplus insignis, n. sp.

Reddish-castaneous, apical half of elytra black. Clothed with very short, yellowish pubescence, longer on tip of abdomen than elsewhere; each side with a fringe of very short pubescence.

Upper surface with dense and fine punctures, causing the derm to appear shagreened. Head subtriangular, a shallow depression each side in front, with a few very minute granules. Antennae short, club almost circular. Prothorax gently concave in middle, base not twice as wide as the median length and finely margined, sides evenly rounded in front, feebly incurved near base, apex rather deeply emarginate; with small setiferous granules. Elytra slightly longer than wide; with fine, scarcely punctate striae, the odd interstices each with a row of minute setiferous granules. Abdomen with three segments exposed dorsally, with small setiferous granules, becoming numerous on sides of two first exposed segments; under surface with dense and sharply defined punctures, first segment along middle about once and one-half the length of second, the two combined slightly longer than third, the length of fourth and distinctly shorter than fifth. Mesosternum with somewhat stronger punctures than on abdomen. Prosternum with irregular punctures, middle of apex transversely strigose. Length, 5.5-6.75 mm.

Hab.—Western Australia: Cue (H. W. Brown).

Larger than any species before me, except *B. auritus*, and very distinct by its concave prothorax and colours. In some respects it appears allied to *B. olliffi*, but it differs from the description of that species in having all parts of the upper surface granulate, the granules on the elytra being quite distinct on the alternate interstices, and on the head they are smaller and sparser than elsewhere; the abdomen has only three segments exposed dorsally, and the size is smaller. The fringe on each side is composed of very short hairs, and could be easily overlooked, it is quite even from apex of prothorax to apex of elytra, but on the abdomen is less regular.

BYRRHIDAE.

Byrrhinus convexus Blackb. (formerly *Notiocyphon*).

As three cotypes of *Notiocyphon convexum* Blackb. appeared to belong to the Byrrhidae, although the genus (as a new one) was referred to the Dascillidae, I asked Mr. Arrow to examine the type (now in the British Museum). In reply he stated that it "Belongs to genus *Byrrhinus*, and is near but distinct from (*Trinodes*) *punctipennis* Macl." This coincides with my own opinion.

CLERIDAE.

Tenerus abbreviatus White.

T. ruficollis Macl.

I cannot regard the type of *T. ruficollis* other than as a variety of *T. abbreviatus*; on a series of specimens the large pale apical patch with a conspicuous purplish spot gradually changes, till only a vague space near the apex is pale, the dark spot being quite indistinguishable from its surroundings.

TENEBRIONIDAE.

Saragus strigiventris Lea.

This species was described in a paper (*Trans. Roy. Soc. S. Aust.*, 1915, 795) dealing with the beetles brought back by Captain S. A. White from an expedition into the interior of South Australia, and recorded from the Everard Range; but the only specimen from there was in somewhat damaged condition (its legs and antennae were missing) and so the type was made from a specimen from Eyre's Sand Patch (although this was perhaps not made sufficiently clear in the descrip-

tion). Subsequently Carter stated (PROC. LINN. SOC. N. S. WALES, 1917, 717) that the name was synonymous with *S. sphaeroides*. He has recently kindly allowed me to see the type of that species and I can say with confidence that the two species are distinct. Comparing the types side by side, the following differences may be noted:

S. sphaeroides Cart.	*S. strigiventris* Lea.
Subopaque.	Shining.
Head finely shagreened and with moderately large punctures; each side conspicuously incurved to the side of the clypeal suture.	Head not shagreened and with somewhat sparser and distinctly smaller punctures; each side not at all, or very feebly incurved to the side of the clypeal suture.
Prothorax densely punctate* and finely shagreened.	Prothorax sparsely and finely punctate, and not at all shagreened.
Elytra more coarsely shagreened than prothorax; punctures (owing to shagreening) not very sharply defined; each with three interstices slightly but distinctly elevated above their fellows.	Elytra not shagreened; punctures larger and sharply defined, even posteriorly; without raised interstices.
Apex of front tibia with two spines, the larger of which is blunt-tipped, and almost as long as basal joint of tarsus.	Larger spine smaller and acute.

In addition to the type of *strigiventris* there are seven other specimens from Eyre's Sand Patch now before me (they were overlooked when the species was named), and these all agree with it, and they all differ from the type of *sphaeroides* in the details noted.

The Everard Range specimen is certainly closer in general appearance to the type of *sphaeroides*, and it has faintly elevated elytral interstices, but it differs from the type of that species in having the prothoracic punctures much smaller and sparser (very conspicuously so on the margins), elytra not really shagreened and with more sharply defined, although not larger punctures. On *sphaeroides* the elytral shagreening is distinctly coarser than on the prothorax, and on close examination the surface appears to be very densely granulate-punctate. The Everard Range specimen was picked up dead, and its opaque appearance is evidently due to weathering and not to shagreening.

On passing through Adelaide recently Mr. Carter saw these notes, and commented upon them as follows:—

"With a long series of examples before me, shown by Mr. Lea, from Eyre's Sand Patch, S.A., I am convinced of the clear distinction of *Saragus strigiventris* Lea from *S. sphaeroides* Cart. from Condon, W.A."

MELANDRYIDAE.

ORCHESIA PICTIPENNIS Lea.

A specimen from Victoria appears to belong to this species, but differs from the types in having the prothorax of the same shade of castaneous as most of the elytra; these have very ill-defined markings, which consist on each side of a vaguely infuscate spot near the base, an obscurely flavous spot near the middle, then an infuscate spot, and then another obscurely flavous spot.

* Carter, PROC. LINN. SOC. N. S. WALES, 1911, 197—"Disc of pronotum coarsely punctate."

Orchesia alphabetica, n. sp.

Piceous-brown, sometimes almost black; parts of prothorax, of under surface and of legs usually paler, elytra with sharply defined whitish markings, the suture narrowly castaneous. Clothed with very short, ashen pubescence.

Head evenly convex and with small dense punctures. Antennae rather long and thin, with a loose club. Prothorax widely transverse, base much wider than apex, with three depressions at base, the sublateral ones feeble, the median one still more feeble; punctures small, dense, and inconspicuous. Elytra long and thin; widest just before middle, with a feeble stria on each side of suture and a more sharply defined one near each side; punctures as on prothorax. Hind spurs slightly longer than their supporting tibiae. Length, 3.5-4.5 mm.

Hab.—Tasmania: Cradle Mountain and Waratah (H. J. Carter and A. M. Lea).

An elongate fusiform species, rather longer and thinner than *O. eucalypti*, and with more numerous elytral markings (they are much less numerous than in *O. bryophila*); structurally the species is nearest to *O. medioflava*. Specimens were beaten in abundance from a shrub at Waratah. The elytral markings are in three series; on each elytron they consist of: A, a spot at the basal fourth near the suture, the spot sometimes round, but often shaped like a reversed U or V; B, a series of narrow and usually conjoined markings on the derm near the middle, and commencing (sometimes as an isolated round spot) near the suture; and, C, narrow postmedian markings, commencing as a line running parallel with the suture for a short distance, then directed obliquely forwards, then backwards, and then outwards to the margin at about the apical third. On many specimens the antemedian markings resemble an irregularly placed M, and on many the postmedian ones an irregular W, but the latter are often enlarged, so that the posterior part is directed obliquely from near the suture to the side, but with two or three projections in front; occasionally the subbasal spot is narrowly connected along the suture with the antemedian markings. On one specimen the subbasal and antemedian markings are conjoined to form a large, irregularly angular blotch on each elytron. On some specimens the prothorax is of a dingy flavous or testaceous, with two more or less distinctly infuscated spots.

Tasmosalpingus quadrispilotus Lea.

A specimen from the Dividing Range (Blackburn's collection) differs from the type of this species in being slightly larger and somewhat paler, with the elytra mostly flavous, but leaving the lateral and apical margins infuscated, the suture narrowly infuscated, with, at the middle, the infuscation angularly dilated and connected with a large elongate spot on each elytron; these spots, however, not touching the margins as on one of the Tasmanian specimens; the seriate arrangement of punctures is less noticeable than on the type, but is fairly distinct towards the suture.

Trichosalpingus major, n. sp.

Pale flavo-castaneous, legs and antennae somewhat paler. Clothed with very short, whitish pubescence.

Head wide and feebly convex between eyes, with two shallow depressions in front; punctures small and crowded. Antennae thin, scarcely passing base of prothorax. Prothorax rather strongly transverse, sides moderately dilated near apex, a subangular depression on each side of base; punctures crowded but more sharply defined than on head. Elytra much wider than prothorax, slightly

dilated to beyond the middle; punctures more sharply defined than on prothorax, and rather less crowded; with feeble striation. Length, 5-5.75 mm.

Hab.—South Australia: Mount Lofty Range (R. J. Burton).

Larger than any previously named species and uniformly pale. From some directions parts of the elytra appear to be non-striated, and the striae are nowhere sharply defined and with larger special punctures.

MORDELLIDAE.

Mordella felix Waterh.

Six specimens, from Tasmania (Launceston, Mole Creek and West Tamar), probably represent another variety of this species; they differ from the typical form in being smaller, 3-4 mm., with a large patch of pale pubescence on each shoulder, in addition to the other basal markings, the median V on each elytron longer and narrower, and the subapical fascia conspicuously concave on its inner edge.

Mordella humeralis Waterh., var. exrufa, n. var.

Five specimens from Tasmania (Waratah) have elytral clothing as on normal specimens, but the derm beneath the humeral markings is quite as dark as the rest of the elytra. On a few other Tasmanian specimens the red is scarcely perceptibly indicated.

Mordellistena rhizophorae, n. sp.

Flavous; a slightly infuscated circle at basal third of elytra, tips of hind tibiae and of hind tarsal joints black. With moderately dense, pale pubescence.

Thin and subparallel-sided. Scutellum small and transverse. Pygidium moderately long and acute. Hind tibiae with three oblique black ridges, the first long, the third very short, spurs very unequal; basal joint of tarsi with two long black ridges, the second joint with one. Length, 3 mm.

Hab.—Northern Territory: Darwin, reared in August from a mangrove gall (G. F. Hill).

The slight but distinct circle on the elytra should readily distinguish the present from all previously described species; there is also a vague infuscation near the apex of each elytron. The front and middle legs and the antennae are missing from the type.

Tomoxia obliquialba, n. sp.

Black, base of antennae and palpi obscurely reddish. Clothed with black and whitish pubescence.

Rather wide. Scutellum with sides obliquely cutting into elytra. Pygidium rather short and thin, its tip truncated. Spurs to hind tibiae red and very unequal. Length, 5-5.25 mm.

Hab.—Queensland: South Johnstone River (H. W. Brown).

In some lights parts of the head and prothorax appear to be opalescent, and the dark pubescence to have a purplish gloss. The pale pubescence is dense on the head, margins the side and base of prothorax (from the latter there is a short spur on each side of the middle, as if, with the lateral pubescence, to mark off the three usual large dark spots), scutellum, three lines on elytra and on parts of under surface and legs. The species is structurally close to *T. aterrima*, but the pygidium is narrower and the elytral clothing different; on each of two

specimens there are three distinct white lines on the elytra: a sutural one, and an oblique one from each shoulder to the suture near the apex, but before joining the suture the oblique lines become rather ill-defined.

CURCULIONIDAE.

Myllocerus griseus Lea.

Two specimens of this species, from Wyndham, are in better preservation than the types; their elytral spots are more numerous, sharply defined and black, and the legs (except as to their clothing) are almost entirely black.

Myllocerus armipectus Lea.

Two specimens from Derby appear to belong to this species, but differ from the type in being slightly larger, and in having the clothing of the upper surface of a pale greyish-blue, mottled with very pale brownish spots.

Myllocerus hilli Lea.

Numerous specimens of this species, from Darwin, have the scales more of an emerald-green than golden-green or golden; on several the median vitta of the pronotum is rather feeble, but the lateral ones are nearly always sharply defined. On many of them the elytral setae are longer than on the typical ones, so that they could fairly be regarded as belonging to C, of the 1914 table, where they would be associated with *M. doddi* and *M. setistriatus*; from the former they differ in being smaller, prothorax less convex in middle and trivittate and legs and antennae thinner; from the latter in the antennae being considerably longer and thinner, and front femora much less acutely dentate.

Myllocerus gnopholotus, new name.

M. griseus Lea, 1914, n. pr.

The name *griseus* having been used by Roelofs for a species of *Myllocerus*, from Japan, in 1873, the above substitute is proposed for the Australian species also so named.

Myllocerus bifasciatipennis, new name.

M. fasciatus Blackb., 1889, n. pr.

The name *fasciatus* having been used by Faust for a species of *Myllocerus*, from Suyfun, in 1887, the above substitute is proposed for the Australian species also so named.

Myllocerus scitulus, n. sp.

Piceous-brown or reddish-brown, legs paler. Densely clothed with pale green scales, becoming still paler on head, under surface and legs; prothorax feebly trivirgate, elytra still more feebly maculate; with depressed or subdepressed setae, on the elytra confined to a single row on each interstice.

Head rather wide, with a small median impression. Eyes rather distant and less convex than usual. Rostrum about as long as its basal width, sides almost parallel, gently concave along middle, and apparently without a median carina. Antennae moderately long and thin, bases rather distant; scape moderately curved; first joint of funicle not much, but distinctly, longer than second. Prothorax very little wider than the median length, apex very feebly incurved to

middle and scarcely narrower than base, the latter moderately bisinuate, sides feebly rounded; punctures concealed, but their positions indicated by setae. Elytra much wider than prothorax, parallel-sided to near apex; with rows of punctures in regular striae. Femora feebly dentate, tibiae apparently non-denticulate. Length, 4 mm.

Hab.—Queensland: Dalby (Mrs. F. H. Hobler).

As the prothorax is distinctly (although not deeply) trivirgate, this species could be referred to E. *dd*, of the 1914 table of the genus; from the species placed there (*M. hilli* and *M. sulcicornis*) it differs in being considerably smaller, eyes smaller and less prominent, antennae shorter and elytral setae pressed flat amongst the scales; *M. anoplus*, also from Dalby, is about the same length, but narrower, prothorax longer and not trivirgate and antennae shorter; *M. gratus* (some specimens of which have the prothorax trivirgate) has very different eyes, muzzle, and antennae. The infuscations of the upper surface are not very deep, the elytral spots in particular being very ill-defined; seen directly from above the elytra appear to be without setae, but they are quite distinct from some directions. The elytral punctures appear to be very small and in narrow striae, but on abrasion they are seen to be large and in rather wide striae.

Myllocerus chaunoderus, n. sp.

Black or piceous-brown, legs more or less reddish. Densely clothed with whitish-grey scales, on the upper surface with numerous sooty-brown spots; in addition with short decumbent setae, on the elytra placed in a single row on each interstice; muzzle with some long, whitish bristles.

Head wide. Eyes very prominent. Rostrum scarcely as long as the basal width, gently concave and with a fine median carina. Antennae rather widely separated; scape rather strongly curved, thickened towards apex, under surface slightly grooved at apex; first joint of funicle slightly longer than second. Prothorax strongly dilated to base, the sides there flange-like, wider than elytra, and fully thrice the median length; apex straight, punctures rather sparse and normally concealed. Elytra parallel-sided to near apex; seriate punctures large and in rather deep striae, but appearing small and narrow through clothing. Femora scarcely visibly dentate. Length, 4.5-6 mm.

Hab.—Northern Territory: Groote Eylandt (N. B. Tindale).

The base of the prothorax is usually noticeably wider than the elytra, but on some specimens it is scarcely perceptibly so. In the 1914 table of the genus this species would be associated with *M. laticollis*, from which it is at once distinguished by the under surface of head, this being unarmed in both sexes; *M. latibasis* has the apex of prothorax distinctly incurved to middle. The male is usually smaller than the female, with longer legs and antennae, and less convex abdomen, but there appear to be no external features by which the sex of a single specimen may be determined. The derm is everywhere normally concealed, it is usually black, but occasionally is dark brown or even reddish-brown, the reddish colour of the legs, however, is always evident. On the upper surface the dark spots vary considerably in number and extent, on some specimens they cover most of the elytra and on others less than half; on many specimens they appear more as obscure mottlings than distinct spots; on the pronotum there is usually an obscure vitta towards each side, and occasionally a faint median one; on an occasional specimen some of the scales on the under parts of the head

have a slight bluish gloss. The setae, although not conspicuous, even from the sides, cause the surface in parts to appear speckled (flea-bitten). From most directions the femora appear to be unarmed. Numerous specimens were obtained on wattles, *Acacia* spp.

MYLLOCERUS OBSCURUS, n. sp.

Black, parts of legs sometimes obscurely reddish. Densely clothed with greyish-white scales, becoming almost white on under parts; elytra with obscure brownish spots or mottlings, the prothorax with a wide, median brownish vitta. With stout, depressed setae.

Eyes less convex than usual, rather large and oblong-elliptic. Rostrum slightly longer than wide, sides gently incurved, feebly concave and with a fine carina along middle. Antennae long, rather close together at base; scape moderately curved and thickened at apex; first joint of funicle not quite twice the length of second. Prothorax with base strongly bisinuate and much wider than apex, the latter shorter than the median length; punctures fairly large but normally concealed (although indicated by setae). Elytra not much, but distinctly, wider than base of prothorax; with large punctures in deep striae, but appearing small and thin through clothing. Femora rather feebly dentate, tibiae with small and acute, but normally almost concealed denticulations. Length, 7-8 mm.

Hab.—Northern Territory: Roper River (N. B. Tindale).

In the 1914 table of the genus, this species would be associated with *M. fugitivus* and *M. subrostralis*; from the former it is distinguished by its larger size, shorter rostrum, less prominent eyes, and median vitta; from the latter by the shorter rostrum, sparser setae on upper surface and median vitta. There are five specimens before me but of these only two have the clothing in good condition; on two specimens some of the elytral scales have a slight bluish gloss. The elytral setae, although depressed, are not quite flattened amongst the scales, so that they are fairly distinct from the sides. The tooth on each front femur is small, but appears to be rather acute when the scales have been removed.

MYLLOCERUS TRICARINIROSTRIS, n. sp.

Black, parts of legs obscurely reddish. Densely clothed with scales, mostly black or brownish on the upper surface, whitish or greyish-white on the sides and under parts. Elytra with numerous semi-erect setae, varying in colour with the scales amongst which they are set.

Eyes fairly large but not very convex, oblong-elliptic. Rostrum about as long as its basal width, sides slightly narrowed to apex; with three thin carinae, of which the median one terminates in a narrow inter-ocular fovea, the others almost at the base. Antennae thin and moderately long, fairly distant at base; scape for the genus rather slightly curved, first joint of funicle half as long again as second. Prothorax with base moderately bisinuate and much wider than apex, the latter feebly incurved to middle, and distinctly wider than the median length. Elytra not much wider than base of prothorax, parallel-sided to near apex; with regular rows of apparently rather small punctures, in narrow striae. Femora very feebly dentate; tibiae not denticulate. Length, 6 mm.

Hab.—South Australia: Kingoonya (A. M. Lea).

The elytral setae are not quite as long as in the species referred to B *d*, of the 1914 table, but regarding the species as being placed there, it would be associated

with *M. acutidens*, which is a larger species, with paler scales, longer elytral setae, and base of prothorax narrower in proportion; regarding it as belonging to B *s*, it differs from the four species placed there, in its longer elytral setae; the obscure markings of its upper surface would associate it with *M. castor*, from which it differs in the prothorax wider at base, and with much smaller punctures, and elytra with longer setae. On the only specimen taken the elytral scales, as viewed from above, appear to be mostly black or blackish, with numerous small pale spots, but the scales on six interstices on each side are almost entirely pale; on a wide space towards each side of the pronotum the scales are almost entirely dark. The elytral setae, from the sides, appear to be dense and irregular, but, from directly in front or behind, they are seen to be placed in a single row on each interstice. The upper surface has not been abraded, but the punctures of the pronotum appear to be smaller and closer together than usual, the elytral punctures appear small through the clothing, and they probably are really smaller than on most species, as the elytral scales are unusually small.

MYLLOCERUS HERBIVORUS, n. sp.

Black, parts of legs reddish, densely clothed with green, or greyish-green scales, in addition with numerous short semierect setae, on the elytra condensed to form a row on each interstice.

Eyes prominent and almost round. Rostrum about as long as the basal width, sides feebly incurved, median carina feeble. Antennae long and thin, rather distant at base; scape rather strongly curved, first joint of funicle almost twice the length of second. Prothorax slightly wider than long, apex very feebly incurved to middle and about the width of base, the latter rather feebly bisinuate, sides moderately rounded, with dense and large punctures, normally concealed but indicated by setae. Elytra much wider than prothorax, shoulders rounded, sides almost parallel to near apex in male, slightly more dilated in female, with rows of large punctures in wide striae, but appearing small and narrow through clothing. Legs long, femora very feebly dentate. Length, 4-5 mm.

Hab.—Northern Territory: Connexion Island (N. B. Tindale).

On many specimens the prothorax has one or three faintly infuscated vittae, those with three could be referred to E, of the 1914 table of the genus, where they would be associated with *M. hilli*, from which they differ in having considerably shorter rostrum, eyes smaller and more distant, and elytra with almost uniform scales. Those with the prothorax not trivirgate could be referred to F, or F F; the ones with the scales not green could be associated with *M. foveiceps*, from which they differ in the rostrum being longer and differently impressed, and the prothorax with sides more rounded, base narrower, and less deeply bisinuate; the ones with greenish scales have the sides of the prothorax less strongly rounded than in *M. elegans* and could be associated with *M. mastersi*, to which they are certainly close, but from which they differ in having the sides of the prothorax more strongly rounded, and the scape more evenly and less strongly arched. Some of the more brightly coloured specimens resemble *M. darwini*, but that species has the prothorax more strongly transverse. On many specimens the scales on the under surface and legs are almost white, on others they are as green as those on the elytra; probably on living specimens they are all green. The male is usually smaller than the female, has longer legs and antennae, less convex abdomen and larger punctures. Numerous specimens were taken in long grass by means of the sweep-net.

MYLLOCERUS DECIPIENS, n. sp.

Blackish, parts of legs reddish. Densely clothed with pale greenish-blue scales, on the upper surface with numerous sooty-brown spots, with more or less depressed setae on the elytra, confined to a single row on each interstice.

Head with a narrow inter-ocular impression. Eyes moderately large and oblong-ovate. Rostrum about as long as the basal width, sides gently incurved. Antennae moderately long and thin, bases rather distant; scape moderately curved; first joint of funicle about one-third longer than second. Prothorax slightly narrower than the median length, apex straight and equal to base, which is strongly bisinuate, sides rounded, but arcuate near base; punctures normally concealed but indicated by setae. Elytra about one-third wider than widest part of prothorax, parallel-sided to near apex; with rows of punctures in regular striae. Femora feebly dentate; tibiae not visibly denticulate. Length, 4.5 mm.

Hab.—Northern Territory: Groote Eylandt, unique (N. B. Tindale).

In general appearance strikingly close to *M. sulcicornis*, but eyes larger and closer together, prothorax longer and without a median vitta, and under surface of scape not grooved. The scales are mostly of a pale bluish colour, but regarding them as partly green, the species, in the 1914 table of the genus, should be referred to H, and from each of the species placed there (*M. gratus* and *M. anoplus*) it is distinguished by its larger size, larger and somewhat different eyes, longer antennae and spotted elytra. Regarding the scales as not green, it could be associated with *H. varius*, which has very different eyes, etc. Towards each side of the pronotum there is an irregular dark vitta, on the elytra there are numerous small elongated spots, seldom crossing two interstices and absent from the sides. The median carina of the rostrum is distinct only at the apex, but probably extends to the base, although normally concealed. The elytral punctures appear to be narrow and in narrow striae, but on abrasion they will probably be found to be of considerable size.

MYLLOCERUS AERUGINOSUS, n. sp.

Black or blackish, legs reddish. Densely clothed with golden-green, or bluish-green scales; in addition with numerous flavous setae, on the elytra fairly long and suberect.

Head flatttened between eyes, and with a narrow median impression. Eyes moderately large and oblong-elliptic. Rostrum about as long as its basal width, sides incurved to middle, scarcely concave along middle; without a normally visible median carina. Antennae long and thin, bases distant; scape evenly curved; first joint of funicle about one-third longer than second. Prothorax distinctly transverse, apex slightly incurved to middle and the width of base, this rather strongly bisinuate; with vague transverse impressions near base and apex; punctures large and normally concealed, but indicated by setae. Elytra much wider than prothorax, parallel-sided to near apex; with large punctures in rather wide striae, but appearing small and in narrow striae on account of clothing. Legs rather long; femora slightly but acutely dentate, tibiae not denticulate. Length, 4.5-5 mm.

Hab.—Northern Territory: Groote Eylandt (N. B. Tindale).

The three specimens obtained on the island at first glance appear to belong to *M. darwini*, but they differ from some cotypes in being slightly narrower, the prothorax slightly longer, feebly incurved to middle of apex, and with feeble transverse impressions (somewhat as on *M. rugicollis* but less pronounced);

from *M. mastersi*, to which they also appear to be very close, they differ in the prothorax being slightly shorter, and in the incurvature of apex and transverse impressions; the impressions, however, are less pronounced than on the species referred to F *i*, of the 1914 table, so the species should be referred to L L; *M. carinatus* (there associated with *M. darwini*), is a larger maculate species, with different elytral clothing, and *M. usitatus* (there associated with *M. mastersi*) has edentate femora.

MYLLOCERUS PICTUS, n. sp.

Black, parts of legs obscurely reddish. Densely clothed with bright green scales, interspersed with erect, whitish setae, becoming rather long on elytra.

Eyes rather large and prominent. Rostrum scarcely longer than the basal width, sides feebly incurved, moderately concave along middle, with median carina normally concealed. Antennae long and thin, bases distant; scape moderately curved; first joint of funicle almost twice the length of second. Prothorax moderately transverse, base and apex equal, the former straight, the latter moderately bisinuate; punctures normally concealed but indicated by setae. Elytra much wider than prothorax, feebly dilated to beyond the middle; with regular rows of rather large punctures, but appearing much smaller through clothing. Femora feebly dentate, tibiae not distinctly denticulate. Length, 4.5-5 mm.

Hab.—North Western Australia: Wyndham, in February (J. Clark).

In the 1914 table of the genus this species would be associated with *M. doddi* and *M. setistriatus*, from both of which it is distinguished by its smaller size, feeble dentition and uniformly green scales. Structurally it is fairly close to *M. hilli*, but the prothorax is not vittate, and the setae are longer; at first glance it resembles some specimens of *M. mastersi*, from which it is at once distinguished by the upright elytral setae. In general appearance it is rather close to *M. aeruginosus*, but the eyes are more convex, the basal joint of the funicle is longer, and the elytral setae are longer and more erect.

MYLLOCERUS ARMIPES, n. sp.

♂. Piceous-brown, legs and antennae reddish. Densely clothed with pale slaty-grey scales, becoming almost white on under surface, elytra with numerous small brownish spots.

Eyes rather large and oblong-elliptic. Rostrum slightly shorter than the basal width, sides feebly incurved, median carina normally visible towards apex. Antennae rather long and thin, bases distant; scape moderately curved; first joint of funicle about one-third longer than second. Prothorax moderately transverse, sides strongly rounded but close to base incurved, apex gently incurved to middle and, if anything, slightly wider than base, the latter almost straight; with a vague transverse impression near apex, and another near base; with large punctures, partly concealed, but their positions clearly indicated by setae. Elytra much wider than base of prothorax, parallel-sided to near apex; with rather large punctures in wide striae, but appearing small and narrow through clothing. Basal segment of abdomen shallowly depressed in middle, the apical one rather flat. Femora very stout, strongly and acutely dentate; tibiae long with numerous small denticulations, but each of front ones with a rather large one in middle; front coxae armed. Length, 5.5-6 mm.

Hab.—Queensland (Dr. E. W. Ferguson), Endeavour River (C. French).

Rather closely allied to *M. rugicollis*, but transverse impressions of pronotum less conspicuous and armature of tibiae very different. Regarding the prothorax as slightly wider at the apex than at the base, the species, in the 1914 table of the genus, would be associated with *M. amblyrhinus*, but that species has a wider and more convex head, with rounder and more prominent eyes, and very different armature of the legs; passing that species in the table, and also *M. rugicollis*, it would be associated with *M. fuscomaculatus*, from which it differs in having larger eyes, different prothorax and setae, and very different legs. The elytral setae are pressed flat amongst the scales, so that even from the sides they are scarcely traceable, a few apical ones only are fairly distinct. On the type each front coxa has a small, conical tooth, projecting downwards, and each middle coxa has a still smaller one; the larger tooth of its front tibia is almost as large as the femoral tooth; on a second male the coxal armature is much less distinct, and the larger tibial tooth is much smaller than the femoral one.

BELUS MACULIPENNIS, n. sp.

Dark reddish-brown. Upper surface irregularly clothed with yellowish or stramineous pubescence, becoming white on under surface.

Head rather convex, with crowded punctures. Rostrum long, thin, and slightly curved; with distinct punctures behind antennae, very small elsewhere. Antennae thin, extending beyond middle coxae. Prothorax slightly longer than wide, sides gently rounded and widest near base, with a moderately distinct median line; punctures as on head. Elytra long, thin and parallel-sided, except that the shoulders are rounded, and the apex triangular; with a faint longitudinal depression on apical half near suture and another half-way between suture and each side; with crowded punctures. Legs long; front femora moderately stout, and unarmed; front tibiae moderately curved, lower surface denticulate; front tarsi with basal joint large, about as long as second and third combined. Length (excluding rostrum), 7-8 mm.

Hab.—Queensland: National Park (H. Hacker). Type in Queensland Museum.

Structurally fairly close to *B. filum* and *B. filiformis*, but rostrum considerably longer and thinner, prothorax less dilated towards base, and clothing differently placed. Some parts are darker than others, but only the claws and eyes are black; the rostrum is sometimes paler than the rest of the head, but on three specimens has a dark line (inconspicuous from most directions) from the base to beyond the middle, the apical joint of the antennae is paler than the preceding ones. On the upper surface the clothing margins the eyes, forms three lines on prothorax (the median one narrower than the others), and has a feebly spotted appearance on the elytra, but on each of the six specimens taken by Mr. Hacker there is a large distinct spot on the middle of each elytron, and a streak near the apex, and by these markings it may be readily distinguished; on the metasternum and abdomen the pubescence is dense on the sides, and forms a feeble line on each side of the middle of abdomen, but these are sometimes obscured. From some directions both head and prothorax appear to be densely granulate. The narrow part of the elytra begins suddenly, and a line cutting through them at its commencement would cut off an equilaterally triangular apical portion.

ORCHESTES AUSTRALIAE, n. sp.

Flavo-castaneous; mesosternum, metasternum, and base of abdomen black. Moderately densely clothed with pale pubescence, and golden setae, becoming white on under surface and legs.

Head rather small, inter-ocular space narrow. Eyes large and prominent. Rostrum about the length of prothorax, slightly curved, shining and with small punctures. Prothorax with sides strongly rounded and increasing in width to base, this almost twice the width of apex; with dense, partially concealed punctures. Elytra oblong cordate, not covering pygidium; punctate-striate, interstices with rather large punctures. Hind femora each about as large as prothorax, finely serrated posteriorly. Length, 3 mm.

Hab.—New South Wales: Orange, in January (H. J. Carter).

On the two specimens taken by Mr. Carter, the upper surface appears slightly mottled, owing to the rather patchy distribution of the pubescence. This is the first true *Orchestes* to be recorded from Australia, as *perpusillus*, referred by Pascoe to the genus, has been transferred to *Rhamphus* (Lea, *Proc. Roy. Soc. Vic.*, 26 (n.s.), 1914, p. 226); in the latter genus the claws are simple, in the former they are appendiculate or bifid.

Rhamphus australis Blackb., and R. distinguendus Blackb.

In the original descriptions of these species no mention is made of any kind of clothing, and two cotypes of the former species in the South Australian Museum, and one of the latter, appear to have the upper surface glabrous, except that some minute setae may be traced on the posterior sides of the elytra.

Rhamphus amplipennis, n. sp.

Black, antennae (except club) and tarsi flavous, tip of rostrum obscurely reddish. Upper surface and parts of legs with very short, pale pubescence or setae, on the elytra in two or three almost regular rows on each interstice.

Head with crowded punctures; interocular space from above appearing as a narrow shining line. Rostrum flat, slightly curved, shining, with small punctures, its tip resting on mesosternum. Prothorax with sides strongly dilated from apex to near base where the width is more than twice the median length, with a shining, slightly elevated median line; punctures dense and rather coarse. Elytra dilated from base to beyond the middle, where the width is almost twice that of the prothorax; punctate-striate, punctures in the striae rather large but often obscured, interstices with sharply defined punctures about as large as those at base of head, but less crowded. Length, 2.5 mm.

Hab.—South Australia (Macleay Museum), Mount Lofty Ranges (A. M. Lea).

In several collections this species was standing as *R. australis*, but it may be at once distinguished by the elytral clothing, this consisting of almost uniform rows (two or three on each interstice) of minute pale setae, in some lights causing the upper surface to appear greyish. Its elytra are wider in proportion than in any other species of the genus before me. The species is quite common on the "blackwood", *Acacia melanoxylon*, but its powerful hind femora frequently enable it to escape capture.

Rhamphus megalops, n. sp.

Black; apex of rostrum and tarsi reddish, antennae paler, but club black. Clothed with fine whitish pubescence or setae, on the elytra forming two regular rows on each interstice.

Head with crowded punctures behind the eyes. Eyes large, almost touching at base, the interocular space very narrow to between antennae. Rostrum somewhat flattened, slightly curved, shining, with small punctures, its tip resting

on mesosternum. Prothorax with sides strongly rounded and widest at about basal third; punctures much as on base of head; median line faintly defined or absent. Elytra with sides dilated from base to about apical third, where the width is about one-third more than the greatest width of prothorax; punctate-striate, interstices with somewhat rugose punctures, about as large as those on prothorax. Length, 2.5 mm.

Hab.—South Australia: Tarcoola and Ooldea (E. H. Ising and A. M. Lea).

In general appearance fairly close to the preceding species, and with similar clothing, except that on the elytra the pubescence never appears to be in more than two rows on any interstice; but less robust, and greatest width of prothorax distinctly before the base instead of almost at the extreme base; when the preceding species is viewed from behind, a point is soon reached where the outlines of the prothorax and elytra appear to be continuous, and the basal angles of the former appear to be acute; from the same point the present species appears to be notched on each side, where the elytra and prothorax meet, and the basal angles of the latter to be rounded off. The eyes are even larger than on that species, and seem to touch at the base, instead of being slightly but distinctly separated there. Numerous specimens were obtained on some stunted wattles (*Acacia* sp.) growing between rocks at Tarcoola.

RHAMPHUS MICROSCOPICUS, n. sp.

Black, basal half of antennae and apical fifth of rostrum flavous or reddish. Upper surface with minute pubescence, seriate in arrangement on the elytra.

Head with crowded punctures. Rostrum thin, shining, slightly curved, its tip resting on mesosternum. Prothorax with sides rather strongly dilated to near base, median length more than apical width, but conspicuously less than basal width; with dense and rather sharply defined punctures, but less crowded than on base of head. Elytra with sides dilated to beyond the middle, and subcontinuous with those of prothorax; striate-punctate, the interstices also punctate. Length, 0.9-1 mm.

Hab.—Western Australia: Swan River, Bridgetown, Donnybrook (A. M. Lea).

Decidedly smaller than normal specimens of *R. acaciae*, and consequently one of the smallest weevils in Australia, if not actually the smallest. A few Tasmanian specimens of *R. acaciae* are not much longer, but their elytra are decidedly narrower.

COSSONIDEUS* PASCOEI Woll.

Eleven specimens from Beverley (Western Australia) evidently belong to this species, which is distinct by its pale elytra with the sides (and to a less extent the suture) infuscated, by the large eyes and five-jointed funicle; the middle of the metasternum has also a large pale blotch. In dealing with the genus, as with others of the family, Wollaston used exaggerated expressions, the eyes were described as "excessively large and prominent"; they are certainly larger than is usual in the subfamily, but as their combined width is less than that of the interocular space (the full width of the base of the rostrum) "excessively" is misleading; the legs also are not "exceedingly elongate", being in fact scarcely longer than in many species of *Cossonus* and *Notiosomus*. The male differs from the female in having the antennae inserted slightly nearer the base of rostrum, abdomen with a rather wide depression on basal segment, con-

* In Wollaston's monograph the name was spelt *Cossonideus* on pages 435, 517, and 653, but on page 448 *Cossonidius*; Scudder amended the name to *Cossonoideus*.

tinued on to second and, less distinctly, on to metasternum (on the female it is smaller and confined to the basal segment); punctures especially on under surface, larger and closer together, and front femora more strongly curved on the outer side, and almost straight on the inner; the slight asperities of the femora, mentioned by Wollaston, appear to be remnants of femoral dentition, and are confined to the male.

CHRYSOMELIDAE.

Geloptera parvonitens, n. sp.

♂. Metallic green, under surface black, in parts with a metallic gloss, labrum, antennae and legs flavous.

Head with dense but sharply defined punctures, becoming rather elongated towards base. Antennae long and thin, second joint shorter than third but decidedly wider. Prothorax about twice as wide as long, sides evenly rounded in middle, angles rather acutely armed; punctures rather dense and deep, slightly larger than on head, but not quite as dense. Elytra at base about one-fourth wider than prothorax; basal half with somewhat similar punctures (except the shoulders which are smooth and impunctate), but on apical slope mostly confined to distinct striae. Abdomen with fourth segment distinctly longer than third, and about twice the length of fifth. Femora unarmed. Length, 2.5-2.75 mm.

♀. Differs in being slightly larger, upper surface more or less bronzy, antennae slightly shorter, elytra more dilated, abdomen larger and more convex, with the fourth segment smaller, and legs shorter, with the basal joint of front tarsi smaller.

Hab.—Queensland: National Park (H. Hacker). Type in Queensland Museum.

I refer this species to *Geloptera* as it is certainly close to *G. microcalla*, from which it differs in being smaller and the prothorax with sides quite evenly rounded in middle; it might, however, almost as well have been referred to the glabrous section of *Edusa*, and to the vicinity of *E. glabra* and *E. chlorophana*, from which it differs in being smaller, with consistently larger punctures. On the male only the extreme tip of antennae is infuscated, on one female the whole apical joint and parts of the four preceding ones are infuscated, on two others the infuscation is less pronounced. On one female the upper surface is of a beautiful golden-green, and the punctures near the base of its head are smaller and sparser than on other females.

ENDOMYCHIDAE.

Daulotypus minor, n. sp.

Reddish-flavous, tarsi and palpi paler (almost white), head, prothorax and antennae (tips excepted) deeply infuscated. Moderately clothed with pale, subdepressed pubescence, in addition with suberect setae.

Head with irregularly distributed punctures. Clypeus with a depression on each side. Antennae rather long and thin, first joint moderately stout, slightly longer than third and about twice the length of second, ninth slightly longer than eighth but distinctly wider at apex, tenth slightly longer and distinctly wider than ninth, eleventh almost as long as ninth and tenth combined, its tip obtusely pointed. Prothorax more than twice as wide as long, sides finely margined and somewhat uneven, widest near apex; with a narrow, deep, longitudinal impression on each side of base extending to about the middle; a narrow deep impression close to base; punctures sparse and irregular. Elytra much wider than prothorax, widest at about basal third; with somewhat irregular

rows of rather large punctures, becoming smaller and more confused posteriorly. Abdomen with basal segment, in middle, as long as three following combined; sixth distinct at sides, strongly incurved to and not traceable in middle. Legs rather long and thin. Length, 3-3.25 mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea).

Differs from *D. picticornis* in being considerably smaller, prothorax more convex in middle, with the latero-basal impressions and sides different, basal segment of abdomen larger, femora thinner, labrum somewhat smaller, less conspicuously bilobed in front and antennae uniformly coloured, except for their pale tips. The sides of the prothorax are slightly dentate at the apical third, and again close to the apex, each slight tooth being rendered more distinct by a seta.

COCCINELLIDAE.

Rhizobius discipennis Blackb.

A small, strongly convex, variable species, common in the Cairns district of Queensland; it is readily distinguished from most species of the genus by a conspicuous subsutural row of strong punctures on each elytron, marking the outer edge of a polished space on which the punctures are much smaller than elsewhere.

Form 1.—Elytra with a more or less conspicuous metallic-green gloss, prothorax black. Several cotypes belong to this form.

Form 2.—Like the preceding, but elytra with a violet gloss.

Form 3.—Elytra black, or at least very dark brown, front and sides of prothorax obscurely diluted with red. In addition to many specimens of this form from Cairns, Cooktown, etc., there are two in the South Australian Museum from Melville Island.

Form 4.—Elytra blackish, with a conspicuous reddish vitta on each, the two conjoined near apex; prothorax more or less obscurely reddish. There are many specimens intermediate between this form and the preceding one, as the vittae are traceable, although not sharply defined.

Form 5.—Upper surface of a uniform pale castaneous-brown, or at most the suture and sides slightly infuscated. Several cotypes belong to this form.

Rhizobius xanthurus Muls.

R. tricolor Lea.

The elytra of this species are of uniform colour throughout, although varying in individuals from a rather bright blue to deep purple. It occurs in South Australia, Victoria and Tasmania.

Rhizobius hirtellus Crotch.

R. ruficollis Blackb.

This species occurs in Queensland, New South Wales, Victoria, Tasmania, South Australia and Western Australia. In Blackburn's table of the genus (*Trans. Roy. Soc. S. Aust.*, 1892, 258) *R. hirtellus* and *R. ruficollis* are bracketed together as having "Prothorax entirely bright rufous, in strong contrast to the elytra," but on the preceding page he stated that he considered them to be distinct. Standing in his collection* was a single specimen from Queensland

* In his note-book, under No. 5220, recorded also as *hirtellus*.

labelled as *hirtellus* (and I have taken eight of the same species on Mount Tambourine), but this species has whitish hairs only on the elytra, decidedly long ones mingled with others of moderate length† whereas Crotch says "pubescence suberect, ashy, intermingled with long black hairs." The prothorax is occasionally uniformly red, but usually it has an infuscate medio-basal blotch (this blotch is faint but traceable on a cotype of *ruficollis*); on a few specimens the blotch is blackish and sharply defined. One South Australian specimen has the elytra partly purple, and many have the longer hairs dark brown but mingled with paler ones.

RHIZOBIUS CARNIFEX Muls.
R. calomeloides Lea.

This species, which occurs in South Australia, Victoria, and Tasmania, varies considerably in size (4.5-6.5 mm.) and the dark prothoracic markings are more sharply limited on some specimens than on others; two, from Victoria, have the prothorax entirely red and the suture conspicuously red throughout. The specimens from Tasmania named *R. calomeloides*, are smaller and with less sharply defined markings than usual.

RHIZOBIUS STRAGULATUS Er.
R. blackburni Lea.

This species was originally referred to *Scymnus* by Erichson; it was unknown to Mulsant; Crotch referred it to *Midus*, but queried it as possibly a *Rhizobius*; in Masters's Catalogue it appears as a *Pharus*. Blackburn in 1892 commented on the species as unknown to him; in 1901 he commented on some of Erichson's types sent to him by Prof. Kolbe, but without mentioning (either then or subsequently) any Coccinellidae. In his collection, however, were two specimens marked "*Lithophilus stragulatus* Er. compared with type"; and these specimens agree with the original description, and with the type of *blackburni*. I think I was right in referring the species to *Rhizobius*, its coarsely granulated eyes, abdomen, antennae and legs are all in agreement with many species of that genus, the form is certainly more depressed than usual, but this alone could not be considered as of generic importance.

RHIZOBIUS PYGMAEUS Blackb. (formerly *Midus*).

This species is certainly congeneric with the preceding one, and hence should also be referred to *Rhizobius*; it bears a strong resemblance to *Scymnus corticalis* Lea, but that species has the face more vertical, eyes much more finely faceted, prothorax much more transverse, under surface with much smaller punctures and abdomen different.

CHILOCORUS BAILEYI Blackb.

The type of this species had the elytra entirely dark, and belongs to a rare form; others in the Blackburn collection, from Cairns, and the majority I have taken there myself, have each shoulder flavous, occasionally each flavous part is small and vaguely indicated, on others it is very conspicuous and occupies more than half the base of each elytron; on such specimens the prothorax is usually entirely flavous, or at most with a basal infuscation.

† These specimens probably represent a variety of *hirtellus*.

THE SALINITY OF INSHORE OCEANIC WATERS OF AUSTRALASIA IN RELATION TO FISHES.

By W. J. Phillipps, F.L.S., Dominion Museum, N.Z., and
F. J. T. Grigg, M.Sc., Dominion Laboratory, N.Z.

(*Communicated by Professor H. G. Chapman*).
[Read 25th November, 1925.]

Introduction.

According to the Challenger Handbook (*Science of the Sea*, 1912), seawater contains from 3.5% to 4% of salts, but if the percentage of salt falls considerably, true marine algae are scarce. Marine algae have an optimum, maximum and minimum limit with regard to salinity as well as with regard to light and temperature. The object of this paper is to introduce the study of the salinity of comparative inshore areas of Australasian waters to shed light on the distribution of plankton and on fish life. We believe that too many investigators in the past have neglected to balance the whole of the influences at work in the destruction of plankton, and too many theories with too little observation behind them have been made on the influence of minor currents and bacterial action in temperate zones of both hemispheres. The collection of a large number of samples on a given day at tide specified has enabled us to prepare a paper along different lines from other observers chiefly owing to the fact that samples have been *simultaneously* collected over so large an area of ocean.

Analyses made by Dittmar show that the relative proportions of the minor constituent salts of seawater to the major sodium chloride content are remarkably constant, and it was therefore considered that complete analysis of the minor salts would serve no useful purpose. We therefore confined our attention to accurate determinations of chlorine present in chlorides, which may be taken as a satisfactory index of total salinity. The chlorine determinations were made volumetrically by titration with silver nitrate, which had been carefully standardized against both British Drug House (Analytical Reagent) and Merck's (Guaranteed Reagent) sodium chloride. An analysis was, however, made of a typical New Zealand seawater and was found to correspond closely to the mean analysis of Dittmar (both calculated to the same chlorine content). We have preferred to express our results in terms of percentage of chlorine (as chlorides) rather than as total solids calculated from these values by an arbitrary factor after the manner of Dittmar (in Challenger Reports) and others.

In connection with assistance rendered in the collection of samples, we desire to make special mention of the following, to each of whom we are indebted for assistance:—Mr. E. B. Harkness, State Fisheries Dept., Sydney; Mr. F. Lewis, Chief Inspector of Fisheries, Melbourne; Mr. Bruce, Chief Inspector of Fisheries, Adelaide; Mr. D. Carter, N. Z. Union S. S. Co., Auckland; Capt. Hammond, Northern S. S. Co.; Mr. S. Reid, Portland Cement Co.; Miss A. I. Mackay, Urenui School; and Mr. E. D. Crawford, Tararu.

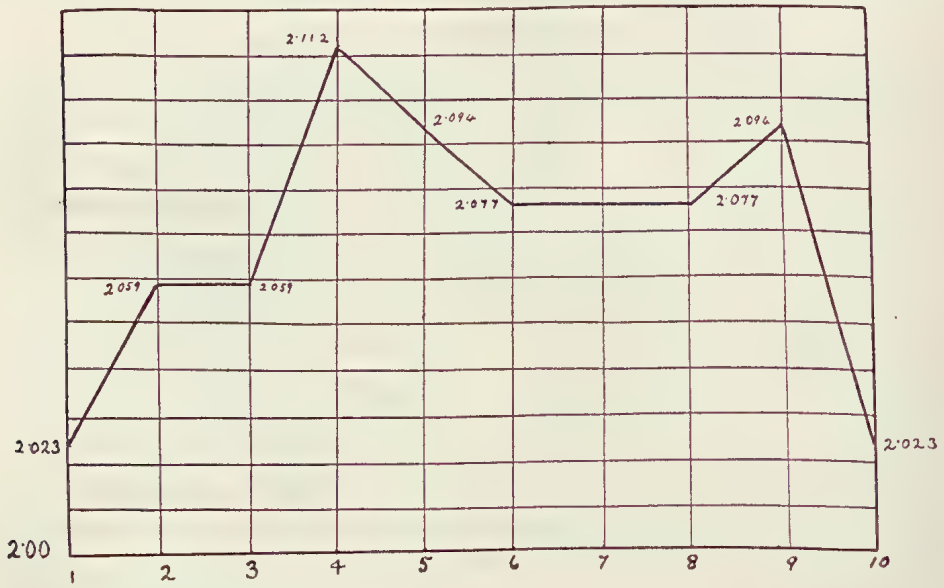
Salinity Determinations of Australian Seawater.

No.	Date.	Locality.	Collected by.	Chlorine per cent.
1	23rd Oct., 1923	Fremantle	The Harbour Master	2.094
2	12th Dec., 1923	Fremantle	The Harbour Master	2.094
3	6th Sept., 1923	Port Adelaide ..	Mr. Bruce	2.112
4	6th Sept., 1923	Port Lincoln ...	Mr. W. D. Randall	2.112
5	6th Sept., 1923	Port Pirie	Mr. A. Frinsdorf ..	2.467
6	6th Sept., 1923	South Channel, Port Phillip ..	Mr. W. J. McCulloch	2.041
7	6th Sept., 1923	Westernport Bay	Mr. G. J. Ward ..	2.077
8	6th Sept., 1923	Bass Strait	Mr. C. J. Beck	2.077
9	6th Sept., 1923	Port Phillip Bay	Mr. Lewis	2.059
10	6th Sept., 1923	Port Fairy	Mr. J. Northey	2.077
11	5th Sept., 1923	North of Cape Hawke	S.S. Maianbar (per Mr. E. B. Harkness)	2.094
12	5th Sept., 1923	East of Cape Hawke	S.S. Maianbar (per Mr. E. B. Harkness)	2.094
13	5th Sept., 1923	South of Cape Hawke	S.S. Maianbar (per Mr. E. B. Harkness)	2.094
14	5th Sept., 1923	Off Camden Haven	S.S. Yulgilbar (per Mr. E. B. Harkness)	2.094
15	5th Sept., 1923	S. Lat. 29° 44′ .. E. Long. 153° 21½′	S.S. Pulganbar (per Mr. E. B. Harkness)	2.094
16	5th Sept., 1923	S. Lat. 29° 35′ .. E. Long. 153° 23′	S.S. Pulganbar (per Mr. E. B. Harkness)	2.094
17	5th Sept., 1923	Korogoro Point	S.S. Wollongbar (per Mr. E. B. Harkness)	2.094
18	5th Sept., 1923	Korogoro Point	S.S. Wollongbar (per Mr. E. B. Harkness)	2.094
19	5th Sept., 1923	East of Tacking Point	S.S. Wollongbar (per Mr. E. B. Harkness)	2.094
20	5th Sept., 1923	S. Lat. 32° 54′ .. E. Long 151° 55′	(per Mr. E. B. Harkness)	2.077
21	5th Sept., 1923	North of Smoky Cape	J. Anderson (per Mr. E. B. Harkness)	2.077
22	12th Dec., 1923	Rockhampton ..	Mr. N. Ladlay	2.147

Australian samples.—The average chlorine percentage in samples of water collected on the Australian coasts was 2.102. This estimate includes the abnormal sample secured at Port Pirie. Taking the Australian States separately, we find average salinities to give results very similar in most cases. Western Australia, with 2.094 on both the 23rd October and the 12th December, has apparently a fairly constant salinity at Port Fremantle during the early summer months. As might perhaps have been expected, samples from Spencer and St. Vincent Gulfs showed the highest recorded salinity. Evidently Kangaroo Island, off Point Victoria, effectually prevents the influence of the volume of water brought down by the river Murray lowering the salinity of Investigator Strait and the Great Australian Bight. The average of South Australian samples was 2.230% chlorine. It is interesting to note that Westernport Bay, Bass Strait, and Port Fairy had each 2.077% chlorine, which amount is also that of the highest recorded sample from New Zealand, taken by Captain Aspden in the Bay of Plenty.

Tasman Sea.—In order to ascertain something of the nature of the water between New Zealand and Australia, we considered it advisable to have samples

collected for us at regular intervals across the Tasman Sea by the mail steamer between Wellington and Sydney. On being approached, the Chief Engineer on the S.S. Ulimaroa kindly consented to do this for us, and some ten samples were taken at regular intervals of from nine to ten hours, the first being collected nine hours after leaving Wellington Harbour and the last in Sydney Harbour. By a curious coincidence these two samples of water had the same salinity. It would appear at this season that, some three hundred miles off the New Zealand coast, the salinity rises slightly and remains higher than usual around New Zealand until just before the Australian coast when a further rise is noticeable. The total distance from Wellington to Sydney is 1,240 miles, and, from our graph below, we may determine that the influence of tropical waters in the Tasman Sea was at this season strongest on the eastern coast-line of Australia and also several hundred miles west of New Zealand. There is, of course, the possibility that the higher



Intervals of 9 hours each.

Graph to indicate changing salinity between Wellington, N.Z., and Sydney, August, 1923.

Salinity Determinations: Tasman Sea, Wellington to Sydney.

No.	Date.	Locality.	Chlorine per cent.
1	24th Aug., 1923	40° 15′ S. Lat. 172° 41′ E. Long	2.023
2	25th Aug., 1923	39° 30′ S. Lat. 170° 20′ E. Long	2.059
3	25th Aug., 1923	38° 50′ S. Lat. 167° 33′ E. Long	2.059
4	25th Aug., 1923	38° 02′ S. Lat. 164° 47′ E. Long	2.112
5	26th Aug., 1923	37° 12′ S. Lat. 162° 08′ E. Long	2.094
6	26th Aug., 1923	36° 31′ S. Lat. 159° 33′ E. Long	2.077
7	27th Aug., 1923	35° 45′ S. Lat. 156° 59′ E. Long	2.077
8	27th Aug., 1923	35° 02′ S. Lat. 154° 28′ E. Long	2.077
9	27th Aug., 1923	34° 10′ S. Lat. 152° 21′ E. Long	2.094
10	28th Aug., 1923	Sydney Harbour	2.023

salinity on the Australian coast-line may be due to the vicinity of the great land mass causing greater evaporation; but this does not account for the rise to the west of New Zealand.

Further evidence of constancy in the chlorine constituent over short periods is afforded by comparison of the results from the Tasman Sea with those of New South Wales coasts. The sample taken just off Sydney Heads (No. 9) agreed exactly with other samples collected off various points of the New South Wales coast-line over a week later.

New Zealand Samples.—A study of the comparative salinities of water samples taken on our coasts appears to prove that, given equable weather conditions, there is no difference in general salinity at this season between North Auckland and Stewart Island. Save for the influence of the Taieri and Clutha Rivers we are at a loss to account for the salinity on the east coast of Otago, which at Bluff and St. Clair was found to be lower than might have been expected, while at Port Chalmers and Warrington the average rose distinctly. Though taken some distance from the river mouth, the Oamaru sample showed distinctly the influence of the Waitaki River. There is a possibility that throughout the year the Canterbury Bight and the east coast of Otago have a lower average inshore salinity than most other parts of New Zealand. The rise in salinity at Stewart Island would appear to show that no influence of large bodies of fresh water ice melting at the Antarctic affected the most southern limits of the New Zealand coast-lines at this time. In general, salinity around New Zealand is distinctly lower than found in the case of Australian samples.

Salinity in relation to Plankton.—We have found that marine diatoms cease movement in a few minutes when transferred to water of 1.5% salinity, and similarly that freshwater infusorians and diatoms cease movement in a like solution. In each case, as far as we could ascertain, the organisms ultimately died. As far as our examinations of river water in New Zealand have gone, living organic life has been small. The Clutha River in Otago is estimated to discharge into the sea 1,000,000 cubic feet of water per minute. The sea which it meets contains always quantities of diatoms which will ultimately die or are prevented from increasing by the influx of freshwater, while all organic material in the freshwater of the river is killed and finds a resting place in the bed of the ocean off the mouth of the river. Where a river discharges its contents into the sea, this process has been going on for ages. Eddies and minor currents carry the river water and its refuse along the coast in varying directions according to weather and tide conditions. Heavy rains must also be responsible for loss of considerable quantities of marine plankton. In the open seas, particularly in tropical zones where salinity and temperature are highest, denitrifying bacteria have been shown to cause enormous destruction of diatoms; but that denitrifying bacteria could increase to the same extent in areas of low salinity appears improbable.

Latitude.—Latitude is an undoubted factor in dealing with comparative salinities of ocean areas, for latitude and trade winds determine approximately the amount of heat and hence the degree of evaporation likely to occur. As a possible solution for the high degree of salinity in water from South Australia, we may mention that there is a possibility that the great land areas adjoining, with warm winds from the interior, would cause an evaporation more intense than elsewhere in Australia or New Zealand. Furthermore, there is the possibility that water in the Spencer Gulf and probably in the Australian Bight is held in a kind of pocket outside the influence of minor currents and eddies. Actually Port

Salinity Determinations of Water Samples collected around New Zealand at Full Tide on 6th September, 1923.

No.	Locality.	Collected by	Chlorine per cent.
1	Mangonui (S.S. Clansman)	S. J. Weston	1.988
2	Whananaki (North Auckland)	W. Nimmo	2.006
3	1 m. S. Tiri Tiri (S.S. Manaia) ..	W. Hizard	1.935
4	Near Sail Rock (S.S. Ronaki)	(per S. Reid)	2.041
5	Little Barrier Island	Caretaker	2.023
6	Puhoi Wharf (S.S. Omana)	F. Nichols	0.302
7	5 mls. S.E. Slipper Isl. (S.S. Ngapuhi)	R. T. Mudie	2.059
8	N.E. Kawau Isl. (S.S. Apanui)	A. W. Price	2.041
9	2 mls. Whangarei (S.S. Mahurangi)	(per S. Reid)	2.041
10	Hauraki Gulf, 27 mls. Pt. Fitzroy (S.S. Waiotaki)	W. N. Stone	2.023
11	Inner Harbour, Auckland (S.S. Claymore)	H. Lister	1.935
12	Auckland, Queen's Wharf	W. Ponsford	1.952
13	Tararu, Thames (S.S. Wakatere) ..	E. L. Baggertrom	1.899
14	Thames Wharf	J. R. Miles	1.846
15	37° 38′ S. 177° E., Bay of Plenty ..	Capt. E. W. Aspden	2.077
16	36° 43½′ S. 175° 49½′ E. Bay of Plenty	Capt. E. W. Aspden	2.059
17	Moturiki, Bay of Plenty	Dr. Bucknill	2.023
18	Te Awaroa, E. Cape	J. I. Miller	1.970
19	Gisborne Roadstead (S.S. Flora) ..	(per D. Carter) ...	1.970
20	Wairui Beach, Gisborne	F. Foote	2.006
21	New Wharf, Petone	W.J.P.	1.970
22	Old Wharf, Petone	W.J.P.	1.970
23	Off Ward Island, Port Nicholson ..	G. N. Shaw	1.952
24	Somes Island, Port Nicholson	G. N. Shaw	1.988
25	Off Point Jerningham	Capt. Inkster	1.118
26	Off Point Jerningham	Capt. Inkster	1.828
27	Off Point Halswell	Capt. Inkster	1.988
28	Ferry Wharf, Pt. Nicholson	Capt. Inkster	1.988
29	Urenui Beach	Miss Wyn. Sheard	2.006
30	Urenui Beach	J. Carr	1.544
31	Raglan Beach	W. R. Moore	1.935
32	Waikato Heads (S.S. Arapawa) ...	F. W. Pressley	1.704
33	Off Manakau Heads (S.S. Rarawa)	Alex. Brown	2.005
34	Wairopa Channel, Manakau (S.S. Rimu)	J. Blackwood	1.828
35	Pelorus Sound	F. Godsiff	1.935
36	Picton Wharf	Capt. T. Barnsdale	1.970
37	Tory Channel, Queen Charlotte Sound	M. Kenny	2.006
38	The Wharf, Westport	A. J. Tointon	0.089
39	Off Flagstaff, Westport	A. J. Tointon	2.006
40	½ ml. from Hokitika R. mouth	W. B. Braddon	1.935
41	Okarito	H. Friend	2.023
42	Half Moon Bay, Stewart Island ...	Mrs. A. Gregg	2.006
43	Bluff	(per G. C. Carnie)	1.935
44	St. Clair	Headmaster	1.935
45	Dunedin Wharf	R. F. Phillipps ...	1.917
46	Port Chalmers	Sec., Otago Har. Bd.	1.988
47	Warrington	H. McQueen	1.952
48	Oamaru	H. Hall	1.278
49	Timaru	(Rector, High School)	1.970
50	Lyttelton	T. W. Hunter	1.952
51	Akaroa	Chas. Hall	1.597

Pirie has a higher latitude than Cape Maria Van Diemen. New Zealand samples were taken between 47° and 34° South Lat., and Australian samples between 23° and 40° South Lat. Weather records showed a uniformity of good weather throughout New Zealand on 6th September, 1923.

We conclude that all fresh water from rivers or rain undoubtedly destroys or retards the growth of certain marine organisms which help to form the ultimate food of the fishes. River and stream water organisms, in however small quantities, perish on arrival in the ocean. Marine plankton and the copepods and other crustacea, as well as other minute vegetable feeders, would thus be more common at a distance from the mouths of rivers; and as if in proof of our contention, we find the largest coastal fishing grounds to be well away from the mouths of large rivers. There are, of course, many fish which enter and remain in brackish water from choice; but these do not constitute any very considerable portion of the total food fishes of Australasia, as they are less particular in choice of food and often become less desirable for human consumption after continued residence in brackish water.

DESCRIPTIONS OF NEW SPECIES OF *LEAIA*.

By JOHN MITCHELL, late Principal of the Technical College and School of Mines, Newcastle, N.S.W.

(Plates xli-xliii.)

[Read 25th November, 1925.]

Introduction.

The history of the genus *Leaia*, as far as Australia is concerned, is a brief one. The first Australian specimens of the genus were found by the writer (1890) in some fragments of chert rock, used to macadamize the main road between Belmont and Charlestown, and hence were not *in situ*. These specimens were handed to the late R. Etheridge, Jr., for identification, and later were described by him (PROC. LINN. SOC. N.S.W., (2) vii, 1892) under the name of *Leaia mitchelli*. Subsequently, from a load of the same kind of material referred to above, placed by the roadside at Belmont, Lake Macquarie, for conversion into road metal, the writer had the good luck to discover a number of beautifully preserved fossil insect wings (1898), which proved, and are still proving to possess special scientific value. After much search, the quarries yielding the rocks containing the phyllopods and insect remains were located, and since then many additional fossil examples of *Leaia* and insects have been gathered, among which quite a number of new types occur.

As will appear from the contents of this paper, new species, or varieties, as the case may be, of *Leaia*, found since the publication of the late Mr. Etheridge's paper descriptive of the first species of that genus from Australia, prove to be so numerous as to make it advisable to extend the history of the genus.

An outstanding feature in connection with *Leaia* in the Newcastle Coal Measures, is the relatively large number of species or varieties found together in the Belmont Beds in a stratum not more than half an inch in thickness. From this layer have been obtained several forms more or less resembling *L. leidyi* Lea, and *L. mitchelli* Eth. Junr., several tricarinate species, one quadricarinate, one unicarinate (?), and a discoidal form; and further, it is to be noted that odd examples are met with in these measures throughout a thickness of some six hundred feet, from the Dirty Coal Seam up to the Belmont Beds; and throughout this same range also, fossil insect remains are in evidence as well as *Estheria* in considerable variety; these latter it is intended to describe later.

The fossil flora and fauna associated with the *Leaia* now under discussion go to show that they were dwellers in fresh, quiet, and shallow water; and their end, in the Belmont Beds, was brought about by the sudden drying up of the waters, aided by an invasion over the area of much volcanic dust. This would account for the large number of fossil *Leaia* now found in the thin layer of rock in the Belmont quarries referred to above. It may be pointed out here that the so-called chert rock of the Belmont quarries, which is met with also in thin

beds at different horizons in the Newcastle Coal Measures, has been declared by Mr. Card, Curator and Mineralogist, Geological and Mining Museum, Sydney, to be composed of volcanic dust, and his view has had general acceptance; hence these rocks are tuffs.

In the Newcastle Coal Measures, from beds some eight hundred feet or more below the Belmont Beds, and over three hundred feet lower in the series than the Dirty Coal Seam (the lowest horizon from which *Leaia* has been obtained), specimens of a beautifully preserved fish (*Elonichthys davidi*) were collected. This genus is very characteristic of later Palaeozoic rocks in Europe and North America (A. Smith Woodward, *Mem. Geol. Surv. N.S.W.*, 1908); but the *Elonichthys semilineatus* described by A. Smith Woodward (*loc. cit.*) from the brick clay-pits of St. Peters, Sydney, is of Mesozoic age, and therefore the occurrence of *Elonichthys* in the Newcastle measures affords no definite evidence of their age.

The classification of *Leaia* in the present paper has been to the writer a somewhat difficult task, and he admits exception may be taken by some to the manner in which the classification has been completed; he has followed the example set by the late T. Rupert Jones in his Monograph of the Fossil Estheriae (*Mem. Pal. Soc.*, 1862), where he separated the individuals of the genus *Leaia* dealt with by him, from one another, varietally at least, on very small differences.

A feature quickly noticed in *Leaia* from the Belmont Beds is their flatness. This probably arises from the delicacy of the shells, and the rapid deposition of sediment immediately they had been overtaken by disaster.

The late Mr. Etheridge, when describing the first species of *Leaia* found in these measures, did not discuss its value from a stratigraphical point of view. This is remarkable, as the writer is of opinion that no other fossil obtained from these measures indicates so distinctly the palaeozoic age of the rocks; he considers that neither the abundant fossil flora nor the remarkable and varied insects from these measures show conclusively whether they are of Permian or Lower Triassic age. *Leaia*, however, has never been found in rocks younger than Permian, and its presence in considerable abundance in the Newcastle Coal-measures seems reasonable proof that these rocks are not newer than Permian.

Another point worthy of notice in connection with these Belmont Beds is the distinct evidence they afford of the waning of the *Glossopteris* and *Phyllotheca* types of flora. Fragments even of the latter genus are rarely met with, while several species of the former genus which occur abundantly in strata belonging to the Dirty Coal Seam horizon, are here not in evidence. Among these may be enumerated *Glossopteris Browniana* (the true type), *G. ampla*, *G. arachnoides*, etc. *G. linearis* still persists, and is here the commonest species met with, as are also those exceptionally long persistent genera *Gangamopteris* and *Noeggerathiopsis*, and more than one new form of *Glossopteris* makes its appearance here, seemingly, for the first time in the Newcastle measures.

A recent examination of the stratigraphical position of the Belmont insect beds has led the writer to the conclusion that the position given to them by Dr. Tillyard (Proc. Linn. Soc. N.S.W., xlii, Pt. 4, 1917) from information supplied to him by the writer, is much too low, and for that the writer is entirely to blame. At the present time the Broken Hill Proprietary Coy. is opening up a coal mine within a few hundred yards of these Belmont fossil insect beds; and the shafts being sunk in connection with this mine afford reliable data on which the stratigraphical position of these beds may be determined fairly accurately. These

particulars have been generously supplied to the writer by J. Jeffries, Esq., Superintendent of that Company's coal mines, and by J. Fallins, Esq., manager. The stratigraphical position of these fossil insect beds is one hundred and eighty feet above the seam of coal known as the Australasian seam; and eighty feet above the coal seam outcropping at sea level at the South Head of Lake Macquarie entrance; they lie between the Pilot Seam below, and the Great Northern Seam above. This position places them some four hundred feet higher in the series than they were formerly placed, but still well within the Permian System.

My sincere thanks are tendered to W. C. Davies, Esq., Photographer, of the Cawthron Institute, Nelson, New Zealand, for the excellent photographs which illustrate this paper, as well as to Dr. R. J. Tillyard, F.R.S., who was instrumental in obtaining Mr. Davies's services; also to Mr. W. S. Dun, Palaeontologist, Dept. of Mines, Sydney, for help freely given to the writer while engaged on the present paper; and for the same reason they are extended to Dr. A. B. Walkom.

Family Limnadidae.

Genus LEAIA.

LEAIA MITCHELLI, Eth., Jr. Pl. xli, figs 1 and 2; Pl. xliii, fig. 19.
PROC. LINN. SOC. N.S.W., (2) vii, 1892.

Outline of valves suboval or subsemicircular, dorsal line straight, other margins rounded; each valve bears the two radials typical of the genus dividing it into three unequal areas, of which the anterior one is the smallest and nearly semicircular, the middle area is the largest, and it and the posterior one are triangular, the radials originate at the umbo in close proximity, the anterior one is gently curved and almost vertically directed to the ventral margin; the posterior radial is straight, except for a gentle curve near its origin, and reaches the ventro-posterior margins at their junction, forming an angle with the dorsal line of approximately 45°; the concentric growth lines number from eight to fourteen according to age and size, the latter being the maximum; they are fairly regularly spaced, very gently curved on the posterior and medial areas, but strongly so on the anterior lobe; these striae, as they cross the radials, produce a frill-like pattern. The late R. Etheridge, Junr., refers to an emargination of the posterior margin in his description of the species which I have not been able to recognize.

The grounds on which specific rank was conferred upon this *Leaia* were fully explained in the original description. It may further be pointed out that, in Mr. Etheridge's description of the species, the umbones are said to be sharp; but in no case among the many hundreds of specimens that have come under my notice, has such an umbo been observed; in most cases the umbones are indistinctly indicated and not prominent.

The following are the dimensions (length and width) in millimetres of a few more or less mature individuals: 7.8, 5.5; 7.8, 4.7; 6.25, 4.7 (3 examples). These dimensions are fairly constant as far as relative length to width is concerned. The figures given of the specimens from which the original description was made are only crude sketches, partly owing to the imperfection of the specimens which were then available.

LEAIA INTERMEDIATA, n. sp. Pl. xli, figs. 3 and 4.

Outline of valves scaphoidal or subsemicircular; each valve bears two prominent hollow radials which reach to the edge of the borders and a third short

one posterior to the two principal ones, the anterior one very slightly curved and inclined posteriorly, the middle one straight, except for a short sharp curve near its origin, obliquely directed towards the posterior latero-ventral margin at an angle of about 30°; the posterior rib reaches less than half the distance across the valve, dorsal line straight, the other margins distinctly rounded, and have thin edges; concentric growth lines about twelve in number and evenly spaced, and in passing over the anterior and posterior radials form on them a frill-like pattern. In outline and most other respects this form resembles *L. mitchelli* and, but for its third rib, might be placed with that species. From *L. kleiveriana* it differs by having the short rib posteriorly instead of intermediately placed. From other tricarinate types it is separated by the shortness of its third rib.

Dimensions: Length 10.0 mm., width 7.5 mm. (the largest specimen known); the type (Pl. xli, fig. 3) is 7.0 mm. long and 5.0 mm. wide.

LEAIA OBLONGA, n. sp. Pl. xli, fig. 5; Pl. xliii, fig. 18.

Outline subtrapezoidal or suboblong; anterior end strongly rounded, posterior one very slightly so, ventral margin nearly straight and parallel with the dorsal line; the lateral radials originate in the same point at the umbo, the anterior one is mildly curved, directed towards the ventral margin with a very gentle posterior inclination, the posterior one straight but for a slight curve at the umbo and makes with the dorsal line an angle of about 30°; concentric striae thirteen in number, perhaps fourteen, mildly curved, and regularly spaced, posterior area much larger than either of the other two; umbo mildly tumid. Dimensions: Length 11.0 mm., width 3.9 mm. approx.

This is a rare form and has up to the present been found only in the Belmont beds. Its distinguishing features are (1) great proportionate length to width, (2) trapezoidal or oblong shape, (3) large size of the posterior area.

LEAIA DISCOIDEA, n. sp. Pl. xli, fig. 6; Pl. xliii, fig. 22.

Shape discoidal; each valve bears the two radials typical of members of the genus *Leaia*, originating at the umbo rather far apart, anterior one gently curved and terminating much short of ventral margin, the other straight; posterior area segmental in shape, less than a semicircle, smaller than either of the other two, the medial one being the largest; the concentric growth lines are too faint to be recognized; umbo indistinct and less anterior than in other species of the genus; the length and width are about equal.

On first acquaintance with this odd form of *Leaia* it appeared to the writer likely to be merely an abnormal specimen of one or other of the more common types associated with it, but, as several specimens having identical characters have been obtained, this idea has been relinquished for the acceptance of it as a new species. The features on which its specific rank is based are: (1) Its discoidal outline, (2) small posterior area, (3) comparatively short anterior carina. *Loc.*—Chert quarries, near Belmont.

LEAIA QUADRIRADIATA, n. sp. Pl. xli, fig. 7.

Contour of the valves much the same as those of *L. mitchelli*; differs from that species chiefly in the following points: Two extra weak and short radials on each valve, the one anterior and quite close to margin, the other posterior and

close to the dorsal margin; the latter is more distinct than the former, and traverses and extends along the valve for about two-thirds of the distance between its origin and the posterior margin; the anterior one is much shorter; the two strong radials, typical of the genus, increase in stoutness for about two-thirds of their length and then gradually obsolesce, and do not reach the margin; the greater number of concentric striae (apparently sixteen or more) on its valves. The distinguishing feature of the species is its possession of four radials. In contour it resembles also *L. intermediata* (mihi).

Dimensions: Length 4.0 mm., width or height 3.0 mm. These dimensions, though less than the average for most of the local forms, are greater than those given for either *L. leidyi*, *L. leidyi* var. *williamsoniana*, or *L. leidyi* var. *salteriana*.

LEAIA PARALEIDYI, n. sp. Pl. xli, fig. 8.

Left valve subquadrate, flat, dorsal margin straight, anterior subtriangular, posterior one mildly rounded, as is also the ventral one, umbo quite anterior and under it, anteriorly, there is a slight emargination; the radials originate in a point at the umbo, are stout, of uniform dimensions throughout, imbricated by the concentric striae, the posterior one is straight and makes an angle of 30° with the dorsal margin, anterior one very gently curved, and meets the anteroventral margin slightly posterior of the vertical from its point of origin; concentric striae are nine to ten in number, distinct, regularly spaced, and fairly uniformly increasing their distance apart as they recede from the umbo; all are curved, those on the anterior area strongly, but those on the posterior and medial areas mildly, so. Dimensions: Length 8.0 mm., width 6.0 mm.

This *Leaia* so closely resembles *L. leidyi* that it is with hesitation I separate it from that species. The points of difference relied upon for the separation are (1) the local form is much the larger, and differs materially in its proportion of length to width (height), 4: 3, as against 5: 3, or 12: 7 for *L. leidyi*, (2) the emargination of the anterior border just under the umbo, (3) the rounded margins of the local form, (4) its curved anterior carina, and (5) the triangular shape of the anterior area or lobe of the local form as against a semicircular one in the other. The species now being dealt with, and *L. leidyi*, var. *williamsoniana* Jones, also are much alike, but the latter is much the smaller, and its posterior carina makes with the dorsal margin an angle of 45° while in the former this angle is 30°. The difference in these two angles seems to me to have much significance. In comparing and contrasting the present species with *L. mitchelli*, one is confronted at once with a great difficulty in the incomplete and more or less inaccurate figures which accompany the description of that species. The only feature of the valves which they give that can be relied upon is their outline. The outline of the present species is more nearly oblong than is *L. mitchelli*, and all the margins, except the dorsal one which is straight, of the latter species, are more uniformly rounded than is the case with the similar margins of the former; in the latter, too, the concentric striae are more numerous than they are in the former, and the latter is the more elongate of the two; the subtriangular shape of the anterior lobe of the former, as against the semicircular form of that of the latter, helps to distinguish the one from the other; the proportion of length to width in the latter is 3: 2, and in the former 4: 3, approximately in each case.

Loc.—Chert quarries, near Belmont, Lake Macquarie, Parish of Kahibah, County Northumberland.

Horizon.—A short distance above the old Cardiff Coal Seam worked on the north-western shore of Belmont Bay (Great Northern Seam of David).

LEAIA PINCOMBEI, n. sp. Pl. xlii, fig. 9.

Outline of valves subscaphoidal, mildly oblique, bicarinate, carinae originate rather widely apart, very gradually increase in cross section as they recede from the umbo; concentric striae twenty at least; their distance apart gradually increases as they recede from the umbo until the borders are approached, when they become more compacted; the anterior lobe is subelliptic, relatively small; dorsal margin mildly sinuate, hollow and prominent; anterior and ventral margins rounded, posterior one subtruncate. The posterior radial meets the dorsal margin at an angle of 30° and is nearly straight; the anterior one meets the same margin at an angle of 75° and is also practically straight.

Dimensions: Length 7.0 mm., width 5.0 mm.

The distinguishing features of this species are (1) the numerous concentric striae, (2) smallness of the anterior lobe, (3) straightness of the anterior carina, (4) mild sinuosity of the dorsal margin, and (5) obliquity of the valves.

Same locality as the preceding species.

Dedicated to Mr. T. H. Pincombe, B.A., headmaster of the Public School, Wallsend.

LEAIA ELLIPTICA, n. sp. Pl. xlii, fig. 10.

Outline of valves subelliptic, bicarinate; carinae originate rather widely apart, prominent, of equal cross section throughout their length; the posterior one makes with the dorsal margin an angle of 30°; both are practically straight and barely reach the ventral margin; of the three parts into which the shell is divided by the carinae, the anterior one is semicircular and the smallest, the middle one relatively large and posterior one relatively small; dorsal margin straight, ventral margin almost so, anterior one forms the arc of a semicircular anterior division; posterior margin very strongly rounded and protrusive; umbo indistinct; concentric striae about sixteen in number, distinct; as they cross the anterior and posterior divisions they are decidedly curved, but only very slightly so on the middle division, very evenly spaced.

Dimensions: Length 5.7 mm., height 3.2 mm., ratio 7: 4 nearly.

This variety belongs to the *L. mitchelli* type, from which it differs in having a greater proportionate length to width, more decidedly rounded and protrusive posterior margin, straighter ventral margin, relatively smaller posterior division, and apparently relatively larger anterior division; also radials more slender and of even cross section throughout their length, and in the slight obliquity of its valves.

Same locality as the preceding.

LEAIA OVATA, n. sp. Pl. xlii, fig. 12.

Outline scaphoidal, much longer than wide, anterior and posterior margins distinctly rounded, ventral subparallel to the dorsal one, which is straight, two typical radials present, dividing the surfaces of the valves into three unequal parts or lobes; these radials reach, or nearly so, the ventral margin, are of uniform section throughout, anterior one gently curved and reaches the junction of the antero-ventral margins, posterior of a vertical drawn from its point of origin; the posterior radial is straight, except for a distinct, short curve near its

point of origin; the concentric growth lines are fourteen in number, evenly spaced, strongly curved on the anterior lobe, nearly straight on the medial lobe and distinctly curved on the posterior lobe; posterior to the principal pair of radials is a very short one which, viewed from the inside of a valve, much resembles a socket for a hinge tooth; it is so short that to consider it a radial seems quite inadvisable; umbo pointed; dorso-posterior lateral angle, decidedly rounded.

Dimensions: Length 5 mm., width 3 mm.

This form is so closely related to *L. mitchelli* that it is with much hesitation I decide on its separation from that species; the reasons for doing so are (1) the concentric striae are more numerous on its valves than are found on the valves of any specimens of *L. mitchelli* of an equal size, (2) the greater disparity between its proportional length and width (5: 3) as compared with 3: 2 for the other, (3) the even sectional diameter of its radials throughout their length as against a gradual thickening of these parts in *L. mitchelli* as they recede from the umbo. The differences between these two forms enumerated above are admittedly not great; but, when it is recognized that in this genus there are only a small number of superficial features, on which their classification has to be worked out, there appears some necessity to take into account even slight variations of these parts which may be observed in the different individuals.

Loc.—Near Belmont.

Horizon.—Not much above the coal seam, outcropping nearly at sea level on the north shore of Belmont Bay.

LEAIA LATISSIMA, n. sp. Pl. xlii, fig. 11.

It is not necessary to describe this in detail, as a glance at the figure will at once reveal its characteristic features. Its valves are subquadrate; the radials do not reach the margins, the anterior one is mildly curved, increases in size as it recedes from the umbo; the posterior one is straight, of uniform size throughout, and meets the dorsal border at an angle of about 40°; all the margins, except the dorsal, which is straight, are distinctly rounded, concentric striae apparently eleven in number, widely spaced, distinctly curved, indistinct on the posterior lobe, lateral and ventral borders wide.

Dimensions: Length 8.8 mm., width 6.7 mm., ratio 4: 3.

The size of this species is greater than the ordinary for most *Leaia*, and the linear character of the posterior carina is rather unusual.

Same locality and horizon as the preceding.

LEAIA COMPTA, n. sp. Pl. xlii, fig. 14.

Outline subscaphoidal, dorsal margin straight, slightly oblique between the dorso-lateral angle (posterior) and the umbo, thickened, nodulated; anterior margin semicircular, posterior margin very mildly curved, and the ventral one distinctly so; the two typical carinae are present on each valve, are fairly strong, of even dimensions throughout their whole length, hardly reach to the edge of ventral margin, both gently curved at the umbo; for the rest of its course the posterior is straight, and the same may be said of the anterior one, which terminates very slightly anteriorly of its point of origin; anterior lobe semicircular, and, as is the rule, the other two are triangular, the middle one being the larger; concentric striae twelve, perhaps fourteen, in number and truly concentric with the respective margins; the umbo prominent and tumid.

Dimensions: Length 7.83 mm., width 5.50 mm. (the type specimen).

This is a beautiful and symmetrical *Leaia*, and embodies in itself most of the features generally found in members of the group, and, perhaps, might have ranked simply as a variety of one or other of the forms dealt with in the present paper, for instance, of *L. mitchelli* Eth.; but after careful consideration of its features, specific rank has been proposed for it. From all other local forms it differs in being much more inflated or convex, and in having a more prominent umbo; from the *L. leidyi* types it is separated by the absence of parallelism of the dorsal and ventral margins and the more decided curving of its concentric striae, and also in the possession of a larger number of these latter than most other forms, as well as in its greater size. From *L. mitchelli* it differs in the greater convexity of its valves, more prominent umbo, its carinae being of uniform size throughout their length and not reaching quite to the ventro-lateral margins, in having a semicircular and larger anterior lobe; the ratio between the respective lengths and widths is nearly the same, and in full-grown individuals of each type dimensionally and in the number of their concentric striae they are practically identical.

The type specimen of this species was obtained from a horizon about four hundred feet below the Belmont chert beds, and therefore from a horizon much older than the latter beds.

Loc.—Merewether Beach and Croudace's Hill, Lambton, Parish of Newcastle, County Northumberland.

Horizon.—The Dirty Coal Seam, Newcastle Coal Measures, associated with the characteristic fossil flora of these measures.

LEAIA BELMONTENSIS, n. sp. Pl. xlii, fig. 15.

Outline scaphoid or subsemicircular, dorsal margin straight, mildly thickened and nodulated, ventral and lateral margins rounded, each valve bears three radials or carinae, the posterior one being the strongest but not seeming to reach the dorsal margin; the three originate in a point under the umbo; except for a slight arching near the point of origin the posterior and middle radials are straight, the anterior one very gently curved and reaches the antero-ventral margin decidedly in advance of its point of origin; it is needless to particularize the four areas into which the surface of each valve is divided by the three radials, for the figures of the plates clearly show the characters of these. The concentric growth lines number some fourteen, and on all the areas except the anterior one are very mildly curved, those on the latter surface being strongly curved; as these striae cross the radials they effect a frilling design, more or less distinct; on the posterior and anterior areas the striae are quite regularly spaced, but on the other areas their distance apart gradually increases as they recede from the umbo.

Dimensions.—Length 7.0 mm., width 4.7 mm.

Several tricarinate species of *Leaia* have been described from Europe and North America, and among our forms there are several, whose valves are more or less tricarinate; but the only species I know on which the carinae cross the surface of the valves from umbo to the opposite margins is *L. carinata* Meek and Worthen (*Illinois Geol. Surv. Rep.*, iii, 1868, p. 541) but in that species the third carina is close to and nearly parallel with the dorsal margin. In the local type the third carina is well apart from the dorsal margin and forms with that margin and the posterior margin a subisosceles triangle, and because of this difference our form is separated from the North American species.

Loc.—Chert quarries, near Belmont.

LEAIA COLLINSI, n. sp. Pl. xliii, fig. 16.

Outline subsemicircular, bicarinate, carinae originate completely anteriorly at the umbo in the same point. The photo. of a specimen of the species (Pl. xliii, fig. 16) shows its superficial features so clearly that it is unnecessary to point them out here. The reasons for giving specific rank to this form are (1) the very anterior position of umbo, (2) the distinct curvature of the radials and of the dorsal margin as they recede from their point of origin at the point of the beak, (3) the strongly increasing diameter of the hollow dorsal margin as it recedes from its point of origin (the width of the dorsal margin of this species in this particular is singular), (4) the small number and widely spaced concentric striae, (5) relatively small anterior area, (6) subequality in area of the posterior and middle divisions. These enumerated features are the grounds on which the merit for specific rank of this form are based. Dedicated to my friend, Mr. V. B. Collins, Lecturer in Coal Mining and Mine Surveying, Newcastle Technical College and School of Mines.

Same locality and horizon as the preceding.

LEAIA QUADRATA, n. sp. Pl. xliii, fig. 17.

Outline subquadrate, depth or width apparently nearly equal, bicarinate, carinae originate subcentrally, only moderately so, anterior one distinctly curved and reaches the ventral margin, posterior one straight; concentric striae very numerous (probably twenty), closely spaced adjacent to the ventral margin; dorsal and anterior margins straight, posterior and ventral rounded.

Although the only specimen of this form available, it exhibits features decidedly different from other species known to the writer.

Same locality and horizon as the preceding.

LEAIA SP. INDET. Pl. xliii, fig. 20.

Only a single specimen of this *Leaia* is known. It is of large size, its length being 8.1 mm., and width 5.5 mm., ratio of length to width being approximately 10: 7; its carinae do not reach to the ventral margin, the concentric striae seem to be widely spaced and the outline is suboval; but the features are too indistinct for determination.

Same locality as the preceding.

LEAIA SP. INDET. Pl. xliii, fig. 21.

Outline suboblong, tricarinate, with a fourth ridge running crosswise on the third (probably accidental); anterior and posterior radials straight; concentric striae faint, but appear to be numerous; dorsal margin straight and stout, ventral one mildly curved, anterior and posterior margins distinctly curved. This form differs in several features from *L. intermediata*, for instance, in its more oblong shape, longer third carina, less concentric striae and strong dorsal margin.

EXPLANATION OF PLATES XLI-XLIII.

Plate xli.

1, 2.—Left and right valves of *Leaia mitchelli* R. Eth., Junr.

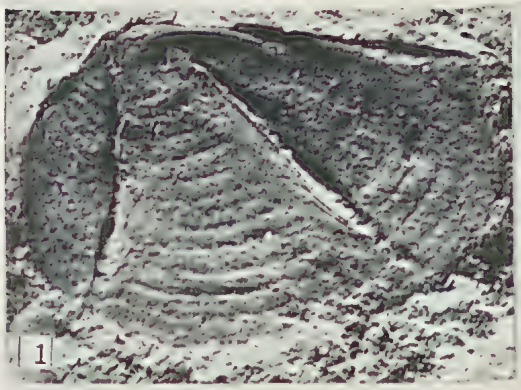
3, 4.—Two left valves of *Leaia intermediata* Mitchell. Fig. 3, × 4; Fig. 4, × 6.

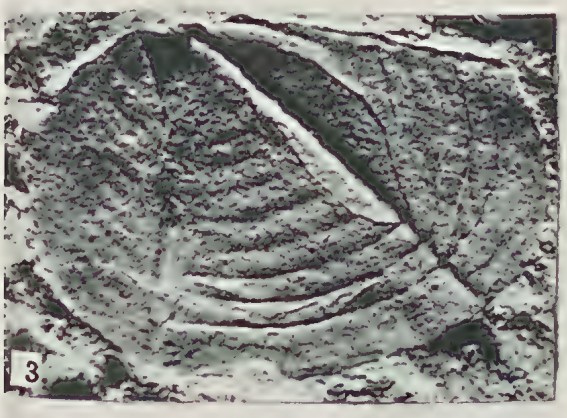
5.—*Leaia oblonga* Mitchell. A right valve of a large specimen posteriorly incomplete; features faintly preserved.

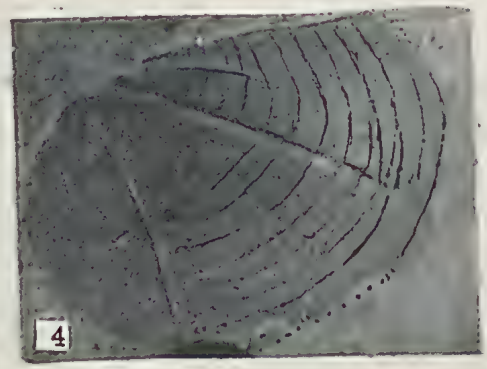
6.—*Leaia discoidea* Mitchell. A nearly complete right valve.

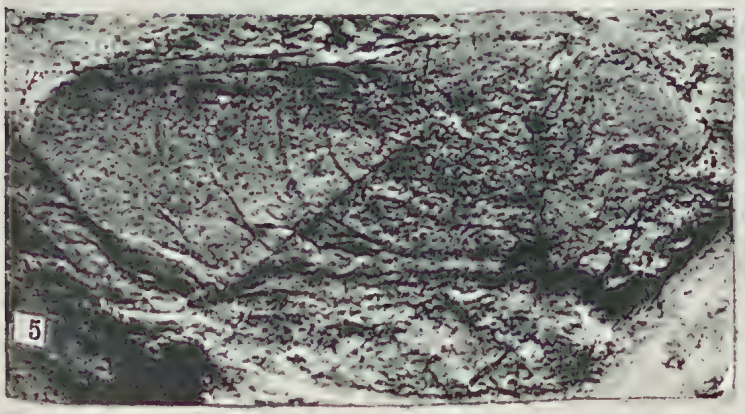
7.—*Leaia quadricarinata* Mitchell. A right valve and a left valve of medium size, perfect in outline, and the features well shown.

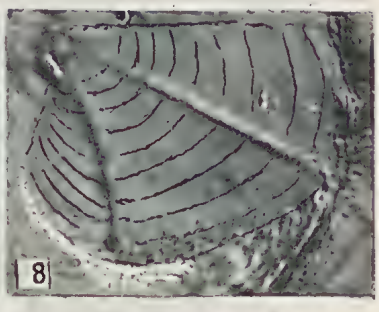
8.—*Leaia paraleidyi*. A well preserved left valve.

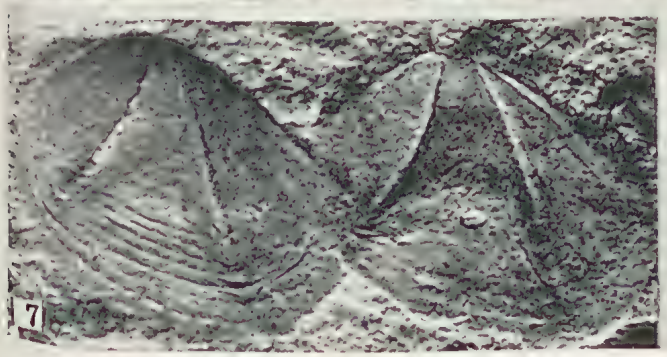




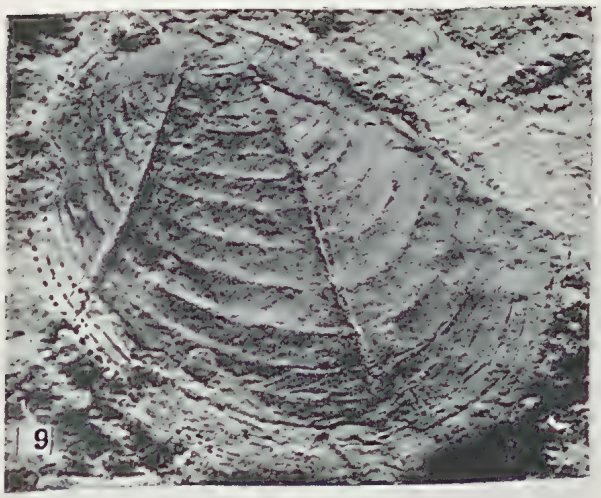


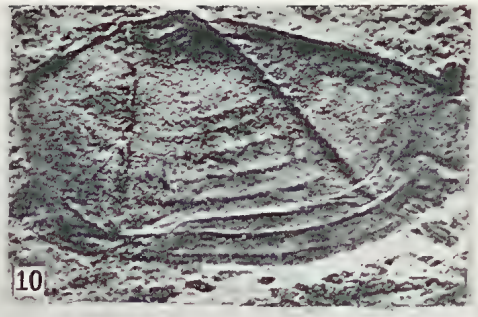


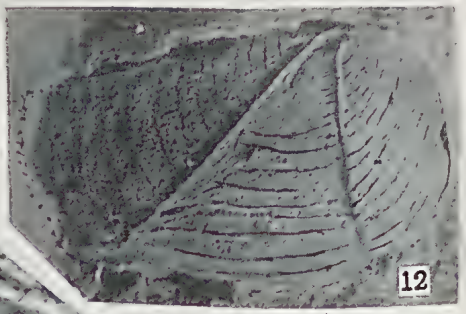


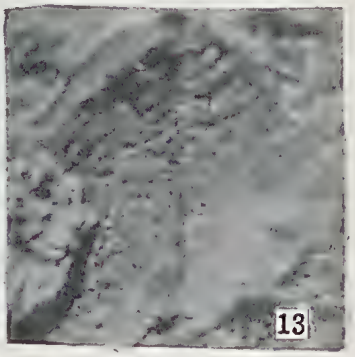


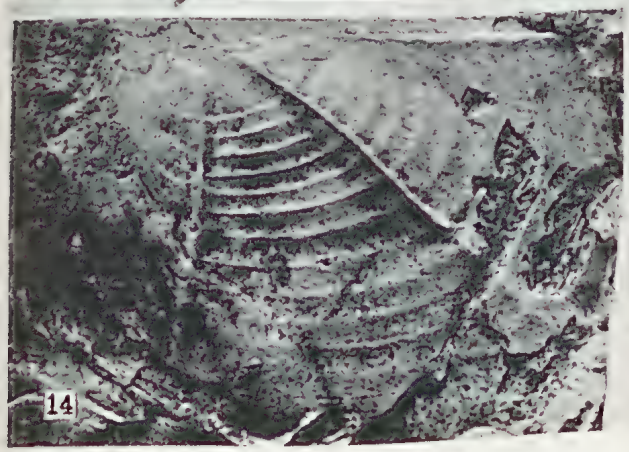
Photos. by W. C. Davies, except 4 and 8. New species of *Leaia*.

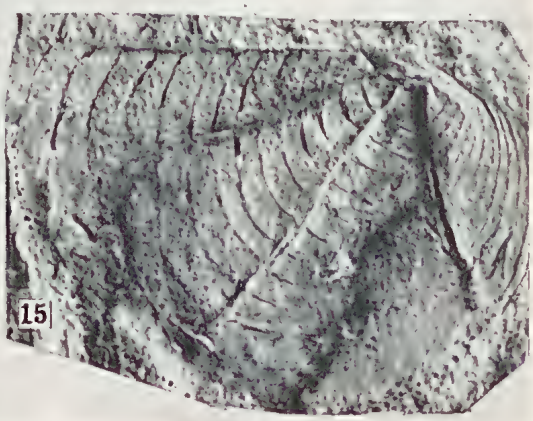






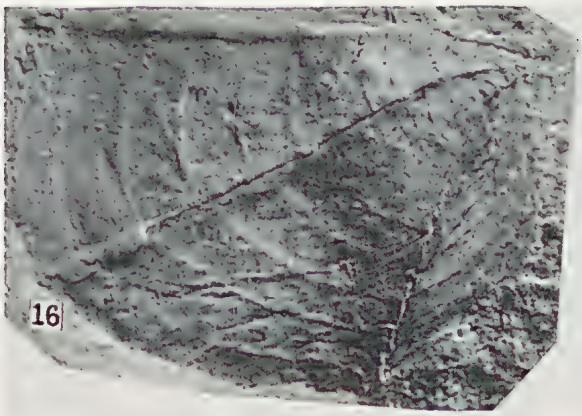


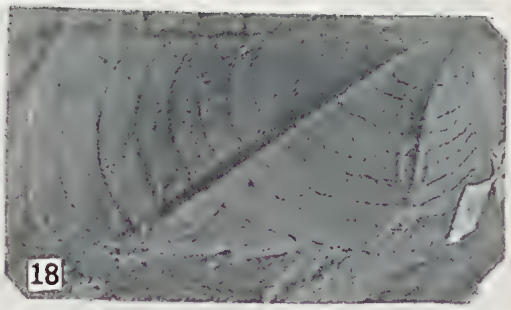


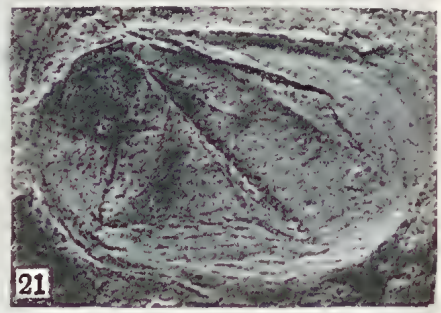


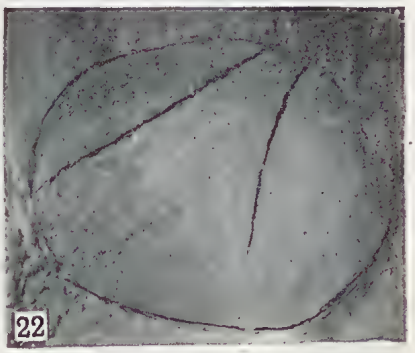
Photos. by W. C. Davies, except 12.

New species of *Leaia*.









Photos. by W. C. Davies, except 18 and 22.

New species of *Leaia*.

Plate xlii.

9.—*Leaia pincombei* Mitchell. A good specimen.
10.—*Leaia elliptica* Mitchell. A well preserved left valve.
11.—*Leaia latissima.* A large and perfect left valve.
12.—*Leaia ovata* Mitchell. Inside view of a left valve. × 6.
13.—*Leaia* sp. indet. An incomplete specimen of what seems to be a monocarinate species.
14.—*Leaia compta* Mitchell. A left valve.
15.—*Leaia belmontensis* Mitchell. An almost perfect right valve.

Plate xliii.

16.—*Leaia collinsi* Mitchell. A splendid right valve.
17.—*Leaia quadrata* Mitchell. An imperfect specimen yet showing the characteristic features of the species.
18.—*Leaia oblonga* Mitchell. A counterpart of a left valve of medium size.
19.—*Leaia mitchelli* (?) Eth., Junr. A beautiful and large specimen of this species.
20.—*Leaia* sp. indet. Features faintly preserved.
21.—*Leaia* sp. indet. A right valve of a tricarinate species near *L. intermediata*; but may prove to be new.
22.—*Leaia discoidea* Mitchell. A left valve perfect in outline but otherwise indistinct. × 6 about.

All the figures of the above plates, where not otherwise indicated, are multiplied ten times.

GEOLOGY OF THE MILTON DISTRICT, N.S.W.

By Ida A. Brown, B.Sc., Geology Department, University of Sydney.

(Plates xliv-xlvi.)

[Read 25th November, 1925.]

A. Introduction and Previous Records.
B. Physiography.
C. General Geology.
Field Occurrence of (1) Sedimentary Rocks; (2) Igneous Rocks.
Nature and Geological Age of the Monzonitic Intrusion.
D. Petrography of Monzonitic Rocks.
(1) The Normal Rocks.
(2) The Albitized Rocks.
E. Chemical Analyses.
F. Albitization and Kindred Phenomena.
G. History of the Intrusion.
Appended Note on Rocks outcropping at Woodburn and Murramarang.

A. *Introduction and Previous Records.*

The village of Milton is situated about forty miles by road south of Nowra, and four miles from the port of Ulladulla, on the South Coast of New South Wales. The town is surrounded by a prosperous dairy-farming district and is a convenient centre from which various scattered outcrops of igneous rocks may be examined. Milton is built on the largest of these outcrops, which has an area of about sixteen square miles. Outcrops of similar rocks occur within a radius of ten miles of the town, exposing a total area of about twenty-five square miles.

The weathering of this igneous rock has yielded a good soil suitable for dairy-farming, so that the outcrops are mostly represented by grassy country, surrounded by virgin eucalyptus forest on the adjacent sandstone.

The earliest published geological report on the igneous rocks of this district appeared in 1905 (Jaquet and Harper, 1905), accompanied by a geological map and sections north and north-west of Croobyar Creek.

Amongst the specimens in the Mining Museum, Sydney, is one (1669) from "near Milton, supposed to have been collected by C. S. Wilkinson, Government Geologist, in 1890, then known as 'Porphyritic Syenite'".

Later, the "Milton Laccolith" was described briefly by Mr. G. W. Card (in Harper, 1915). Also an account of the sedimentary rocks of the district may be found in this Memoir. Reports on the Ulladulla quartzite deposits appeared in the Annual Reports of the Department of Mines, N.S.W., for 1916 and 1918, and also Department of Mines, Geological Survey, N.S.W., Bulletin No. 10, 1924.

B. *Physiography.*

The coastal region in the neighbourhood of Milton consists of undulating country, most of which is not more than three hundred feet above sea level, extending for over six miles back from the coast. To the west there is an abrupt rise to the Milton Tableland, a plateau with an average height of nearly 2,000 feet above sea level, which is dissected in this area by the headwaters of the Clyde River.

Along the coast a number of lagoons, which are generally open to the sea, such as L. Conjola, L. Burrill and L. Toubouree, and the drowned mouth of Croobyar (Narrawallee) Creek, are evidences of recent subsidence of this part of the coast, in common with that of the rest of Eastern Australia.

Evidence of later elevation of the order of twelve to twenty feet may be seen in the raised sea-cut platform along the coast near Ulladulla, and in the slight rejuvenation of the creeks of the district. Croobyar Creek, near its mouth, has cut a new channel through its old alluvial flood plain. The alluvium surrounding the lakes of the district extends to a higher level than is usually reached by the lake waters when the mouths are closed from the sea, and is further evidence of slight elevation.

C. *General Geology.*

Field Occurrence of (1) *Sedimentary Rocks.*

(*a*) *Permo-Carboniferous.*—The sedimentary rocks of the Milton District consist chiefly of the Upper Marine Series of the Permo-Carboniferous System. These beds rest unconformably on the tilted and shattered slates possibly of Ordovician age, which are exposed near the head of Yackengarrah Creek, Parish of Little Forest, and also along the Nowra-Milton Road south of Conjola Creek. The junction between the two systems seems to be somewhat irregular, having a general dip towards the east.

The rocks of the Upper Marine Series are practically level-bedded, having only a very slight general dip in a direction a little to the east of north. The basal beds in this area are the Ulladulla mudstones and sandstones (Harper, 1915, p. 231), which outcrop at intervals for about ten miles along the coast near Ulladulla. It is probable that they have a maximum thickness of less than 400 feet and they thin out rapidly to the west. Certain horizons in these beds are richly fossiliferous (Harper, 1915, pp. 236, 243), and there is abundant evidence of subglacial conditions during this stage, in the occurrence of glendonites and glacial erratics (Brown, 1925, p. 25) in the marine mudstones.

Stratigraphically above the Ulladulla beds are the Nowra grits and sandstones, with the limited development of a coarse basal stage, the Conjola conglomerates (Harper, 1915, p. 231). They overlap the Ulladulla beds to the south and west, and there rest directly on the upturned edges of an older system. They outcrop over a large area and constitute the most southerly extension of the Permo-Carboniferous System in Eastern New South Wales, occurring along the coast almost as far south as Bateman's Bay.

They are essentially level-bedded and expose a maximum thickness of about 1,650 feet in the Little Forest District, a few miles west of Milton, where the series rests unconformably on Ordovician (?) beds at a height of 280 feet above sea level, and extends to the top of the Tableland at the Little Forest Trigonometrical Station, an elevation of 1,829 feet, forming a vertical wall of cliffs 800 feet in height. It is quite likely that the series was originally much thicker. The beds consist of grits and sandstones with occasional current bedding. They

are fairly massive and have given rise to a topography very similar to that of the Hawkesbury Sandstones in the Blue Mountain and Sydney Districts. They are of marine origin and in certain localities contain well-preserved specimens of forms such as *Cleobis*, *Pecten*, *Martiniopsis*, *Spirifer* and *Fenestella*. These fossils may be found at intervals throughout the entire series.

(*b*) *Tertiary.*—In patches, overlying the Upper Marine Beds, are clays and loosely-compacted sandstones, which are difficult to distinguish from the underlying Marine sandstones when weathered. There is a slight angular unconformity between the two series at Bannister Head, but as a rule they are both essentially horizontally bedded.

Some of the clays are carbonaceous and a trace of gold has been found in the sandstone. There has been a certain amount of secondary silicification of the sandstones by Tertiary basalt flows, causing the formation of flinty quartzite, resembling the "grey-billy" of the New England District (David, 1887). This material is quarried as high-grade "silica", and used in the manufacture of silica-brick for steel furnace work. Fragments of silicified wood and roots of an angiosperm are abundant in two of the quarries in the "silica". The occurrence of Tertiary rocks in this district will be described in more detail, in a paper now in the course of preparation.

Field Occurrence of (2) *Igneous Rocks.*

(*a*) *Tertiary.*—Olivine-basalts occur as dykes exposed in cliff sections along the coast near Ulladulla, and also as remnants of flows, in several localities within a couple of miles of the present coastline.

Megascopically the basalt is a black aphanitic rock, sometimes compact but often slightly vesicular, with radiating zeolite partly filling the vesicles.

Under the microscope the rock is a fine, fairly even-grained basalt with pilotaxitic texture, consisting of numerous small phenocrysts of olivine in a groundmass of basic plagioclase (labradorite), augite and olivine granules, with subsidiary apatite and iron ore. In some specimens there are vesicles lined with green-chloritic material and filled with calcite, in others the amygdules consist of radiating zeolite.

The basalt outcropping near the western end of Conjola Lake is a dense black rock, which looks particularly fresh. Under the microscope it is seen to contain a large amount of interstitial calcite, behaving as a primary mineral, which has crystallized last (Browne, 1922, p. 278; Collins, 1913, pp. 66, 69, 81).

(*b*) *Permo-Carboniferous.*—The chief igneous rock of the district is normally dark-coloured, but is always porphyritic in felspar, and thus can be easily distinguished from the later basalts. In general it may be called "monzonite porphyry"; it outcrops over a total area of about twenty-five square miles. The outcrops are by no means ideal, as they are well covered in most places by grassy slopes. Creeks and road cuttings, with occasional small quarries, afford the best opportunities for collecting specimens, but the accurate mapping of the area is difficult. The common bracken fern, *Pteris aquilina*, is sometimes a guide, since it thrives only on the surrounding barren sandstones, and does not grow over the monzonite porphyry, unless the disintegration of rolled boulders of sandstone has made the soil sufficiently porous.

The largest outcrop is sixteen square miles in area, surrounding the town of Milton. Other outcrops occur on the slopes of Little Forest, at the top of the Pointer Mountain, also in the Yatteyattah District and near Conjola. These are shown on the accompanying map.

The boundary of the main intrusion is quite irregular in plan and bears no relation to the contour of the country. It occurs practically at sea level on the main road about a mile north of Milton. and outcrops to the top of Stony Hill at the Milton Trigonometrical Station at an elevation of 316 feet. Bonneyview Hill, four miles south-west of Milton, exposes a thickness of about four hundred feet of monzonite porphyry.

An actual junction of the intrusive mass with the sedimentary rocks, as exposed in a small quarry at the side of the road between Portions 100 and 205, Parish of Ulladulla, is a vertical plane running north-east, dividing level-bedded argillaceous sandstones of the Nowra stage from a fine-grained marginal phase of the Milton rock. This suggests faulting but the junction could not be traced on the surface on account of the grass-covered slopes.

On the south-western margin, the intrusion is bounded roughly by the head-waters of Burrill and Croobyar Creeks. In several places it was noticed that the small creeks had one bank of sandstone and the other of monzonite porphyry, suggesting a shattering of sediments in approximately a north and south direction. Croobyar Creek follows this direction along the margin of the intrusion for a considerable part of its course. The monzonite porphyry has a banded appearance in these areas, due to a kind of platy parting.

A hill in Portion 5, Parish of Ulladulla, on the south side of Narrawallee Creek, is composed of monzonite porphyry on the western side with level-bedded sandstone to the east, outcropping at the same height above sea level. There are also several "islands" of sandstone within the margin of the intrusion. One such area occurs round the Burrill (Woodstock) Public School, four miles from Milton on the road to Termeil, and another occurs on a hill-slope in Portions 75 and 80, Parish of Ulladulla.

The outcrop at Little Forest occurs on the slope leading to the tablelands west of Milton. The creeks flowing east from Little Forest expose level-bedded sandstones under the igneous rock everywhere at a height of about 700 feet above sea level, or 420 feet above the base of the Upper Marine beds. The thickness of the monzonite porphyry is approximately 300 feet. The outcrop on the top of the Pointer Mountain, a short distance north-east of Little Forest, is probably an extension of the Little Forest occurrence.

The outcrop at Yatteyattah extends over an area of one square mile. Currowar Creek, at the Yatta Falls, flows over about eight feet thickness of monzonite porphyry resting horizontally on argillaceous sandstones and grits of the Nowra Series, which are slightly hardened. The junction is approximately 150 feet above sea level. On the main road, about a mile to the east of the Falls, the base of the intrusion is nearly 300 feet above sea level and the thickness is not more than 50 feet. Neighbouring hills are composed entirely of sandstone.

Vertical columnar jointing occurs in the monzonite porphyry in the beds of tributaries of Currowar Creek, Yatteyattah.

The outcrop in Portion 26, Parish of Conjola, is now covered by a well kept farm and was no doubt formerly an extension of the Yatta occurrence.

Mr. L. F. Harper has reported the occurrence of similar rocks in Portions 139 and 162, Parish of Conjola, and is of the opinion that here "The intrusion has not entered the Upper Marine beds but occurs only in the underlying Devonian beds".

Scattered over the land surface near the town of Milton, and also at the Pointer Mountain and the Little Forest outcrop, are boulders of light-grey coloured rocks, locally known as "syenite" or "granite". The rock occurs *in situ* at Stony Hill and to the east.

A coloured photograph of a polished section of this rock has been published (Harper, 1915, p. 134) and it is suggested there that the rock might be useful as a building-stone, but its mode of occurrence and mineralogical composition render it unsuitable for this purpose. Its relation to the normal rock is not very definite in the field, as its distribution is irregular in both horizontal and vertical directions, although it is associated chiefly with the coarser phases of the monzonite.

It is usually a coarse-grained, porphyritic rock, which grades into the normal monzonite. It will be shown later that it is an albitized monzonite.

Through these rocks are segregation-veins, which vary from half an inch to about two feet in width. These veins are commonly coarser-grained than the main mass, and may be referred to as monzonite pegmatite. Frequently, in the central portions there is a very fine-grained felspathic phase, which may be called monzonite aplite.

In the Conjola district, seven miles north of Milton, there are several small outcrops of rocks exactly like the coarse pegmatite veins in the Milton mass. These are undoubtedly apophyses from the monzonitic mass to the south.

Another apparently abnormal rock type, consisting chiefly of quartz and orthoclase, occurs as weathered-out boulders over the southern and south-western portion of the main mass, and over the outcrop at Little Forest. The rock occurs *in situ* as spherical masses or "kernels", included in the normal monzonite, a little to the north of Milton. The rock is described as an aplite, but it has rather a trachytic appearance. Its origin is obscure: it is difficult to imagine that the "kernels" are accidental xenoliths, as they could not have been caught up from the Permo-carboniferous rocks, and the Upper Marine Series in this area rests on a series of early Palaeozoic phyllitic slates, that would not be likely to contain unaltered trachyte.

The similarity in the mineral composition of this aplite to certain narrow aplite veins through the monzonite, and its affinity in chemical composition, suggest possible consanguinity with the monzonitic mass. The matter will be discussed in more detail at a later stage.

Nature and Geological Age of the Intrusion.

From the field evidence available, it seems that the igneous mass in the immediate vicinity of Milton is part of an irregular laccolithic intrusion, which did not reach the surface until it was exposed by erosion. The base is nowhere exposed, although there is a vertical thickness of well over three hundred feet. It is unlikely that the Nowra Beds, into which the mass was injected, ever occupied a position deep in the earth's crust, so that the intrusion is of a hypabyssal character. The other occurrences of similar rock to the west and north seem to be of the nature of sills in the horizontal Nowra Beds, the source of supply of the igneous material having been in the neighbourhood of Milton; hence the whole structure might be conceived as a rather simple type of "cedar-tree" laccolite (Holmes, 1877).

The monzonite porphyry intrudes the lower beds of the Nowra Grits, which belong to the Upper Marine Series of the Permo-Carboniferous System. It will be shown later that it is genetically related to rocks which outcrop north of the Shoalhaven River as a series of flows interbedded with sedimentary rocks of the Upper Marine Series, which are stratigraphically above the Nowra Grits.

Hence the monzonite porphyry of the Milton District is most probably of Upper Marine, Permo-Carboniferous age.

D. *Petrography of the Monzonitic Rocks.*

The igneous rocks outcropping in the areas just described are related to each other closely, both chemically and mineralogically. The normal rock is dark in colour, the texture varying from that of a gabbro to that of a porphyritic basalt, on casual examination.

Chemically the normal rocks contain only about 52% of silica, with 7% of lime and 7% of alkalis; the soda content is only slightly greater than the potash. This represents a rock consisting mineralogically of orthoclase and a basic plagioclase in approximately equal proportions, with augite, some olivine and very subordinate biotite. Apatite and iron ore also are present.

It may be seen that this is a rather peculiar rock type, which appears to belong to the monzonitic series as defined by Brögger (1895, pp. 22-23). It is therefore not surprising to find that specimens from this district, although now generally known as "monzonite", have received in the past a variety of names, just as Brögger (1895, p. 19) found of the rocks of Predazzo and Monzoni in the southern Tyrol.

It is proposed to describe in detail typical specimens of the normal rock and of the segregation veins. The descriptions are based on an examination of hand-specimens and micro-sections of about 45 specimens belonging to the Department of Mines, N.S.W., made available by the courtesy of Mr. G. W. Card, and about 70 specimens collected by the writer in the course of field-work. Altogether nearly 150 micro-sections were examined.

The numbers M.17, etc., refer to specimens now in the Geology Museum of the University of Sydney, and the numbers such as (5105-Slide 2330) are the registered numbers of handspecimens and corresponding micro-sections in the Mining Museum, George Street North, Sydney.

The normal dark rocks may be divided into three main types, which show differences in texture, although they are somewhat similar mineralogically. They are all porphyritic in felspar, with a sub-parallel arrangement of the tabular phenocrysts, and sometimes porphyritic in augite and/or olivine, with a holocrystalline groundmass of felspar (orthoclase and plagioclase), augite, olivine, magnetite, apatite and iron ore. Biotite is accessory.

The coarsest variety outcrops round the town of Milton and for a distance of about a mile to the north, where it is well exposed by a long road cutting. The finer-grained types surround this relatively small area in the main intrusion, and also occur in the smaller isolated outcrops to the west and north.

Typical specimens of the varieties of the normal rock, the albitized monzonite, the segregation veins and the quartz-aplite will now be described.

(1.) *The Normal Rocks.*

Type (1a) Monzonite.

M.1 is typical of the first group. Locality: Stony (or Fig Tree) Hill, ¾ mile from Milton on the road to Nowra, Portion 197, Parish Ulladulla.

In the handspecimen the rock is massive, black, tough and compact. It is phanerocrystalline and porphyritic, phenocrysts of felspar being up to 1 cm. in diameter. In some specimens acicular crystals of apatite are abundant and can be seen easily with the naked eye; they are as much as 5 mm. in length. The groundmass is medium-grained and appears to consist of augite and felspar.

Under the microscope the rock is holocrystalline, porphyritic in plagioclase, phenocrysts being about 1 cm. in length. The average grainsize of the groundmass is medium, about 1 or 2 mm., with hypidiomorphic granular fabric. The minerals present are plagioclase (as phenocrysts and also in the groundmass), orthoclase, augite, iron ore, apatite, pseudomorphs in serpentine and bowlingite after olivine, and a little biotite.

Individual minerals: *Felspar*. Phenocrysts are idiomorphic, tabular crystals, 1 cm. or more in length and about 5 mm. in thickness. Cleavage is well defined parallel to (010) and (001). The refractive indices lie between 1.557 and 1.564. Twinning occurs after Carlsbad, Albite and Pericline laws. The positions of symmetrical extinction make a maximum angle of 30° with the plane of the albite lamellae in the microsections examined. There is no appreciable zoning. This indicates plagioclase of the composition $Ab_{46}An_{54}$, variety Labradorite.

The plagioclase of the groundmass occurs as idiomorphic, tabular crystals up to 2.5 or 3 mm. in length and 0.3 mm. in thickness, with cleavage in two directions and twinning after Carlsbad and Albite laws. Symmetrical extinction angles up to 29° from plane of the albite lamellae were measured on sections perpendicular to (010). Zoning is absent. This plagioclase has therefore, essentially the same chemical composition as that of the phenocrysts—Labradorite ($Ab_{46}An_{54}$).

The plagioclase crystals of both generations are each surrounded by a zone or mantle of orthoclase felspar, always oriented in such a way that its "c" crystallographic axis is parallel to that of the included plagioclase (Plate xlvi, fig. 1). It has a good cleavage in one direction and possesses a series of cracks or imperfect cleavages nearly perpendicular to the planes of twinning of the plagioclase. The refractive index is less than that of Canada Balsam. Simple twinning is occasionally present. There is a maximum extinction angle of 9° measured from the basal cleavage. It is biaxial and negative. There is some decomposition to kaolin.

Pyroxene. Augite (diopside) occurs as idiomorphic to allotriomorphic grains with an average grainsize of less than 0.5 mm. It is colourless or pale grey, with characteristic cleavage and twinning. It is biaxial and positive. The optic axial angle (2V) is approximately 60 degrees.

Iron ore occurs as irregular grains.

Apatite is relatively very abundant, occurring as small acicular crystals and also as large crystals 3 mm. long by 0.2 mm. wide.

Biotite is found as small grains surrounding the iron ore.

Olivine is represented only by distinct pseudomorphs in serpentinous material. Sometimes definite bowlingite is developed.

The order of consolidation is somewhat obscure. The iron ore, at least in part, has crystallized early. Biotite frequently occurs as a narrow zone round the iron ore. The original idiomorphic olivine seems to have crystallized after the iron ore. Pyroxene is sometimes included in the plagioclase, but more often occurs in the borders of the orthoclase which crystallized round idiomorphic plagioclase. This may be due to late crystallization, but the evidence suggests that the grains of augite were pushed aside by the crystallization of the orthoclase. Apatite evidently commenced crystallizing early in the cooling history of the rock, but continued forming until late.

Other specimens belonging to this type show slight mineralogical variations, although it is considered that there can be no serious variation in the chemical composition.

The proportion of orthoclase appears to vary somewhat. This may be due to the nature of its occurrence, wrapping round plagioclase. Specimen 5105 (slide 2330) shows a section of simply twinned orthoclase, which may be surrounding plagioclase above or below the plane of the section.

Plagioclase is fairly uniform in the majority of specimens. Pericline twinning is well developed in several specimens (M. 32 and 2328) and Baveno twinning was also noticed (M. 32). A phenocryst in M. 39 gave a maximum extinction angle of 41°, on a section perpendicular to (010) indicating basic plagioclase (bytownite) of the composition $Ab_{28}An_{72}$. This was the only example observed of plagioclase more basic than labradorite.

Augite generally occurs as small rounded grains, but occasionally assumes greater proportions when a tendency to ophitic fabric is developed, as in (2328), grading into the true ophitic fabric of some of the "light" rocks to be described later. In (2327) and (2328) there is indication of decomposition to greenish chloritic material, but this is rare, the augite being singularly free from alteration products.

Biotite seems to be fairly consistently present in minute amounts. It may occur as individual grains up to 0.3 mm. in length when it may be bleached or altered to chlorite. It is most usually associated with iron ore, either as a result of early crystallization round existing nuclei of iron ore, or perhaps as a kind of reaction rim or synantetic mineral (Sederholm, 1916, p. 2).

Olivine was at first considered to be present in only a small proportion of the specimens collected, but a careful study of micro-sections reveals that it has been a regular constituent of the rock in small amounts.

Olivine is perhaps the first mineral in the rock to suffer alteration, so that it is often only represented by pseudomorphs. Fresh olivine occurs in several specimens, sometimes preserved in plagioclase phenocrysts. Many of the pseudomorphs are very perfect, showing not only the crystal form of olivine, but also the first cracks which led to its decomposition (M. 56, 5105). The pseudomorphs generally consist of fibrous aggregates of serpentinous material, but micaceous bowlingite is not uncommon. Olivine seems to have decomposed to a mass of carbonates and iron ore in M.5 and to quartz and serpentine in (2330).

Apatite may comprise as much as 3% of the total rock, thus accounting for the high value for phosphoric acid in analyses of soil from this district (Jensen, 1910, p. 107). It is generally found as small needles, but sometimes occurs as large crystals, which contain a central cavity filled with chloritic material (Plate xlvi, fig. 2). The mineral itself is the last to be attacked by weathering agents and is only broken down by the organic acids of roots in the soil; the chlorite is probably not a decomposition product, but rather has the apatite in these cases been one of the last products of consolidation (Sederholm, 1916, p. 142) of the rock magma.

Iron ore is largely magnetite; the high TiO_2 percentage in the rock and the occasional presence of leucoxene as a decomposition product indicate the additional presence of ilmenite.

These coarse-grained rocks have evidently cooled down much more slowly than those of finer texture, and consequently were more easily affected by the deuteric processes. As a result, they grade on the one hand into albitized and chloritized rocks, and on the other into normal, finer-grained rocks.

Type (1b) Monzonite Porphyry.

The second type occurs nearer the margin and over the western portion of the main intrusion at Milton, and also in the exposures at Little Forest to the west, and at Yatteyattah to the north.

The rock is finer grained than the preceding type, although still porphyritic. The phenocrysts consist of tabular felspar, set in a fine-grained groundmass. Slightly weathered boulders have a buff-coloured crust, with rectangular pits, from which the felspars have disappeared.

Under the microscope the rock is holocrystalline, porphyritic in crystals of felspar up to 1 cm. in length and also a second generation of smaller phenocrysts of felspar with augite and olivine in a fine-grained groundmass of plagioclase, orthoclase, augite, olivine, biotite, apatite and iron ores. The fabric of the groundmass approaches allotriomorphic granular, although the orthoclase has a nucleus of idiomorphic plagioclase, thus tending to consertal fabric (Plate xlvi, fig. 3).

Individual minerals. Plagioclase occurs in three generations in the same way as it does in some of the flows of the Kiama District. There are a few large phenocrysts about 1 cm. in length, then another series of phenocrysts, which are only about 1 mm. in length, set in a groundmass consisting largely of orthoclase containing cores of plagioclase 0.1 mm. in length. The mineral shows multiple twinning after the Albite law, and frequently interpenetration twinning in the smaller phenocrysts. The maximum extinction angle measured from (010) is 27°, indicating plagioclase of the composition $Ab_{52}\,An_{48}$.

In most micro-sections there is an indication of orthoclase beginning to crystallize round the border of the plagioclase phenocrysts, but some change in the conditions of crystallization must have taken place before it had time to form as in the coarser type. The fine-grained groundmass consists largely of grains of orthoclase, each grain having a tiny core of plagioclase.

Augite occurs as small phenocrysts, about 2 mm. in diameter, and also as tiny rounded grains in the groundmass. It has a pale greenish-grey colour in thin section, and is similar to the pyroxene of the coarser type.

Olivine is found as small phenocrysts and as rounded granules in the groundmass. Fresh olivine is seen in a number of the specimens, but it has been largely replaced by greenish decomposition products such as serpentine and bowlingite. It is by no means abundant, but is a regular constituent of the rock, in small quantities.

Apatite occurs as numerous short needles scattered through the entire rock.

Iron ore.—Numerous small grains of magnetite in the groundmass are frequently surrounded by a narrow zone of *biotite*, which also occurs as small individual grains as a regular minor constituent.

The order of consolidation has been the formation of iron ore, biotite, apatite, olivine and some augite, then the crystallization of the plagioclase phenocrysts, followed by the quick cooling of the rest of the magma, the orthoclase crystallizing last.

Type (1c) Banakite (Latite).

The third type does not differ materially from fine-grained phases of the type previously described, excepting in its finer grainsize (Plate xlvi, fig. 4).

In the field it is found at the margin of the main intrusion and in most of the smaller outcrops in the district.

The handspecimen is black, compact, porphyritic in glassy plagioclase particularly, with a lithoidal, aphanitic groundmass. In a small quarry near Portion 101, Parish of Ulladulla, about one mile south of Milton, specimens of this type were found to contain small quantities of native copper. Copper has been detected previously in the chemical analyses, but until now native copper has not been recorded from here. Its presence in this rock provides additional evidence of its relationship to the flows of the Gerringong district. The Bumbo flow at the foot of Curry's Hill, Gerringong, also contains native copper.

Under the microscope the rock is holocrystalline, porphyritic in plagioclase, augite and olivine, with a microcrystalline groundmass of felspar, augite, olivine, apatite, iron ore and small quantities of biotite. The chief difference between these last two types is the variation in grainsize of the groundmass due to differences in the rate of cooling.

(2) *The Differentiated and Albitized Rocks.*

Type (2a) Albitized Monzonite.

The commonest "altered" rock is porphyritic in opaque white tabular felspar crystals set in a medium-grained groundmass of equal proportions of white felspar and black material filling in the spaces between the idiomorphic felspars. Numerous tiny needles of apatite are distinctly visible to the naked eye.

Under the microscope the rock is somewhat like the coarse monzonite (Plate xlvi, fig. 5). Phenocrysts of plagioclase are surrounded by a mantle of orthoclase, the felspars being idiomorphic. Small idiomorphic to allotriomorphic grains of fresh augite are included in the felspars and also occur between them, as well as acicular crystals of apatite, rounded grains of iron ore and pseudomorphs in serpentine and green pleochroic bowlingite after olivine.

Filling in the spaces between the felspar crystals are masses of spherulitic chloritic material. A few grains of quartz occur in some of the sections, although quartz is absent from the fresh monzonite. A special feature in this rock is the albitization of both the labradorite and the orthoclase felspars. The albite is "spongy", and is accompanied by epidote in the labradorite, and kaolin in the orthoclase. The planes of twinning of the secondary albite after labradorite are parallel to those of the original mineral, while the twinning planes of the albite after orthoclase are perpendicular to this direction and parallel to the cleavage of the original orthoclase.

As is the case in albitized rocks from other districts, the augite is perfectly fresh and is in all respects like the pyroxene of the normal rock. This statement also applies to the apatite. There are a number of pseudomorphs after idiomorphic olivine in serpentinous material, which may have been formed by the same agency as caused the alteration of the felspars.

The chloritic material is either colourless, or has a pale yellowish-green colour, when it is pleochroic. The refractive index is low to medium (about 1.57). It occurs in spherulitic aggregates and has weak double refraction. It sometimes replaces plagioclase felspar, but usually occurs interstitially, and thus seems to be a deuteric mineral, in that it is the last product of crystallization of the rock magma, and not an ordinary product of weathering.

Type (2b) Monzonite Pegmatite.

There are segregation veins running through the albitized monzonite, consisting of rocks, which are not porphyritic, but have an average grainsize of over

5 mm., so that the texture is coarse. The general body colour is greenish-grey. The rock consists of idiomorphic crystals of felspar with interstitial augite and chloritic material. M.30 shows in the handspecimen a white fibrous radiating zeolite, which is a hydrous calcium aluminium silicate, with some potassium and sodium. Its refractive index is slightly less than 1.527, and its elongation is perpendicular to the "c" axis or natural elongation. It is probably prehnite.

Under the microscope the rock consists of felspar, augite, abundant apatite, iron ore and accessory biotite, with interstitial chloritic material, radiating zeolite and calcite. A few grains of analcite were also detected.

There is evidence (i.e. in reflected light) that the felspars originally consisted of plagioclase with a mantle of orthoclase, but they are now completely albitized and kaolinized.

The *augite* is perfectly fresh and often occurs as large plates, which are ophitic towards the felspars (4930). At times it has a faint purplish tint in the centre, when it is pleochroic and probably slightly titaniferous.

Apatite is specially abundant in most of these vein rocks, where it occurs as well formed crystals sometimes having chloritic material in the centre. It seems to have been held in solution until much of the magma had consolidated.

Chloritic material is an important constituent of the rock, occurring in the meshes of the felspars. Some is light-coloured, but there is also present a darker green variety with considerably stronger double refraction, resembling *clinochlore*.

Calcite is found in small quantities in the centre of wedge-shaped patches lined by chlorite, and may be regarded as a late primary constituent of the rock (Browne, 1922, p. 278; Collins, 1913, pp. 66, 69, 81).

Zeolites occur in small quantities as radiating stilbite (?) or as colourless isotropic analcite, which plays an interstitial rôle, as in the intrusion at Prospect (Browne, 1924, p. 240).

Type (2c) Monzonite Aplite.

In places the coarse veins have in their central portions a fine-grained felspathic rock. It has a greenish colour and is generally compact, but in places it is slightly vesicular, with crystals of felspar and chlorite lining the cavities.

Under the microscope the rock is holocrystalline, even-grained, with an average grainsize of about 1 mm. It is very much altered, but consists chiefly of prismatic felspar with very little quartz, interstitial chlorite and a few grains of pyroxene.

The felspar has been completely altered, much albite and kaolin having been developed at the expense of orthoclase.

A partial chemical analysis of one of these rocks (M. 22) gave the result shown in Column A.

	A.	B.
SiO_2	53.45	58.84
CaO	11.15	12.17
Na_2O	5.39	6.91
K_2O	0.15	0.07

A. Monzonite Aplite, Milton.
B. Aplite from James Township, Ontario, N. L. Bowen, analyst.
(Collins, 1913, p. 76.)

The aplite whose analysis is given in Column B, occurs as dykes through diabase, and contains calcite, which is believed to be primary (Collins, 1913, pp. 66, 69, 81).

Type (2d) Aplite.

The only other distinct type belonging to this series occurs in veins through the unaltered monzonite, or as spherical masses included in it.

In the handspecimen the rock is a light grey or yellowish colour. It is very fine-grained, except for the presence of rounded grains of quartz up to 5 mm. in diameter, and is quite compact.

Under the microscope fresh specimens are holocrystalline, slight vesicular, groundmass even-grained, with average grainsize less than 1 mm. (Plate xlvi, fig. 6). They consist of idiomorphic crystals of tabular or prismatic orthoclase, with a fair amount of interstitial quartz, some apatite, magnetite, and some chloritic material. In some specimens there is present a small amount of almost colourless pyroxene and perhaps zircon.

In one specimen (vein in M.5) the orthoclase is slightly kaolinized and in some crystals there are traces of albitization of the orthoclase, accompanied by alteration to kaolin.

Quartz is present in each of the sections of this type, always occurring interstitially with regard to the felspar. A single grain of quartz may include a number of crystals of felspar. It has been the last mineral to crystallize, behaving in the same way as orthoclase usually does in a monzonite.

Small quantities of a pale-green, pleochroic mineral occur, showing a small extinction angle, medium double refraction, and two cleavages at 40°. It is biaxial with a positive interference figure.

Small patches of interstitial spherulitic chlorite are occasionally present.

A partial chemical analysis of this rock (M. 46) gave the following result:—

	A.	B.	C.
SiO_2	69.40	66.13	69.00
CaO	0.92	0.81	0.49
Na_2O	5.22	5.28	5.67
K_2O	4.02	5.60	5.11

A. Aplite, Milton, N.S.W.
B. Akerite I. '5. 1. '3, between Thinghord and Fjelebua, Norway (an. Mauzelius). (Iddings, 1916, p. 203.)
C. Quartz-lindöite, Christiania, Norway. Analyst Schmelck (Iddings, 1916).

It will be seen that this rock is much more acid than any other of the Milton rocks, although apparently comagmatic. This is shown mineralogically by the presence of quartz, while the lime and alkali percentages indicate the presence of the albite and orthoclase molecules.

In column C is given the analysis of a quartz-lindöite (Brögger, 1894, p. 133), which is a differentiation product of a nordmarkitic magma. Its mode of occurrence, fabric and mineral constitution are not unlike those of the Milton rock.

E. *Chemical Analyses.*

Complete chemical analyses of several of the igneous rocks of the Milton District were made by officers of the Department of Mines of New South Wales about twenty years ago.

Three of these analyses correspond to the three main types of the normal rock, which have been previously described. The analyses have been published (Card, 1905, p. 85), but will be quoted in full here, and compared with analyses of rocks of similar composition in other parts of the world.

TABLE OF CHEMICAL ANALYSES.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Specific Gravity.	2.760	2.779	2.768	2.722			2.94		
SiO_2	51.16	53.90	53.21	52.42	54.90	52.63	52.09	58.00	46.73
Al_2O_3	19.16	15.32	17.84	18.05	17.44	16.87	11.93	16.91	10.05
Fe_2O_3	3.98	3.60	3.80	4.30	9.64	4.52	1.84	3.29	3.53
FeO	4.64	5.13	5.22	3.60		3.11	7.11	3.74	8.20
MgO	3.73	2.41	2.96	3.60	3.26	3.69	12.48	1.96	9.68
CaO	6.80	7.30	6.48	6.14	6.96	4.77	7.84	3.60	13.22
Na_2O	4.05	3.73	3.36	3.75	3.50	3.86	2.04	5.14	1.81
K_2O	2.89	3.44	3.03	4.14	3.51	5.17	3.01	5.20	3.76
H_2O (100° C.)	0.72	0.74	0.65	1.47	1.23	3.65	0.35	0.60	1.24
H_2O (100°C+)	1.48	0.97	1.27	1.07			0.16		
CO_2	0.03	0.03	0.02	0.04					
TiO_2	0.84	2.86	1.01	1.16	0.71	0.81	0.73	0.85	0.78
ZrO_2	abs.	abs.	abs.						
P_2O_5	0.56	0.55	0.44	0.34	0.51	0.63	0.34		1.51
SO_3	0.06	abs.	0.09	abs.					
Cl	0.04	0.02	0.11	tr.			tr.		0.18
F	tr.	abs.	abs.						
S (FeS_2) ..	—	abs.	abs.	abs.					
Cr_2O_3	—	abs.	abs.	abs.			0.10		
NiO, CoO ..	0.02	0.02	0.04	0.03			0.07		
MnO	0.26	0.36	0.32	0.28		0.10	0.15	0.80	0.28
BaO	0.08	0.06	0.02	0.11		0.29			
SrO <.01 ..	tr.	tr.	tr.	tr.					
Li_2O (spect)	abs.	pr.	pr.	abs.					
V_2O_5	0.05	0.02	0.01	0.05					
CuO	0.01	0.01	tr.	0.05					
TOTAL ..	100.56	100.47	99.88	100.60		100.10	100.24	100.03	100.97
O = F_2, Cl_2			.02						.04
Total			99.86						100.93

I. Monzonite, Type (1a). Locality, 1 mile north of Milton on the Nowra Road. [Andose, II. 5.3."4. (Washington, 1917, p. 515).] (4916). Analyst, H. P. White.

II. Monzonite Porphyry, Type (1b). Locality, 2½ miles north of Milton on the Nowra Road. [Shoshonose, II. "5.(2) 3.3(4). (Washington, p. 479).] (5107). Analyst, H. P. White.

III. Latite (Banakite), Type (1c). Locality, south side of Croobyar Creek, one mile from Milton on the Nowra Road. [Andose, II. 5.3.(3)4. (Washington, p. 515).] (5092). Analyst, A. H. Greig.

IV. Bumbo Flow. Average of several specimens from Bumbo Quarry. [Shoshonose, II. 5."3. 3". (Washington, p. 479).] Analyst, H. P. White. *Records Geol. Surv. N.S.W.*, 8, 1905-9, p. 12.

V. Monzonite. Brögger's Average Monzonite. Die Triadische Eruptionsfolge bei Predazzo in Südtyrol, p. 51.

VI. Banakite dyke, Hoodoo Mt., Yellowstone Park. Analyst, L. G. Eakins. Quoted from *Journal of Geology*, 3, 1895, p. 947.

VII. Kentallenite, Argyllshire. Analyst, Dr. W. Pollard. Quoted from *Q.J.G.S.*, 1900, p. 537.

VIII. Akerite, Tuft, Laugendal, Norway. Analyst, Schmelck. Quoted from Iddings, *Igneous Rocks*, Vol. II., p. 515, Table 102, No. 21. Monzonose 'II, 5, '2, 3'.

IX. Shonkinite. Analyst Pirsson. Quoted from *Bull. Geol. Soc. Am.* 6, 1895, p. 414.

A study of these analyses shows that the chemical compositions of the three types of the normal Milton rocks are analogous, as was inferred from the microscopical examination. Normative olivine is present in the monzonite and absent in the finer-grained types, its place being taken by normative quartz. In the mode, it was found that olivine was more obvious in the finer rocks.

A comparison of the analyses of the Milton rocks with those of the interbedded flows in the Kiama District, north of Milton, e.g. Bumbo Flow, Cambewarra Flow, Minnamurra Flow, Dapto-Saddleback Flow, etc., points very strongly to the consanguinity of the two series.

This view is borne out by the presence of minute traces of less common elements, such as vanadium, lithium and also cobalt, nickel, copper, barium and manganese.

As stated before, small quantities of native copper, clearly visible in hand-specimens, occur in parts of the Bumbo flow and also in the Milton rock.

Microscopical examination of all these rocks confirms this chemical evidence, for they are mineralogically and, as a rule, texturally comparable. Further, they are grouped together by the C.I.P.W. Classification as Monzonase-Andase.

The composition of Brögger's average monzonite (Brögger, 1895, p. 51) given in column v of the table of analyses is very close to that of the Milton rocks, which agree with the requirements set down by Brögger (p. 53) as to the chemical composition of "monzonites". The coarse variety also agrees with the mineralogical requirements, stated on page 54, although the texture is not such as is generally found in monzonites. This difference in texture is possibly a function of the conditions of consolidation, but is not considered of sufficient importance to justify a new name for the rock. For this reason the name "monzonite" is retained for the coarse phase of the Milton rock.

Analyses of kentallenite (Hill and Kynaston, 1900, p. 531) and shonkinite (Weed and Pirsson, 1895, p. 415) are quoted for comparison in columns vii and ix respectively. Although a small quantity of olivine is present in the Milton rock, the analysis clearly shows that it does not belong to the kentallenite series. The high percentage of magnesia and relatively low percentage of alumina in the kentallenite cause the formation of a rock consisting "essentially of olivine and augite, with smaller amounts of orthoclase, plagioclase and biotite, while apatite and magnetite are accessory".

Although the shonkinites of the Highwood Mts. of Montana are comparable with the monzonites as regards silica and alkalis, they differ widely with respect to lime, magnesia and alumina. This is shown mineralogically by the presence in shonkinite of as much as 50 per cent. of augite, with olivine and biotite, as well as plagioclase, orthoclase and minor accessories.

The fact that the finer-grained varieties of the Milton rock also consist essentially of orthoclase-mantled labradorite leads to a comparison with the absarokite-shoshonite-banakite series of the Absaroka Ranges on the eastern border of Yellowstone National Park. Professor Iddings (1895, p. 935) has described and grouped together a number of rocks occurring as dykes and sills in the Absaroka Range, which have their origin in various centres of volcanic activity, and may be merely similar differentiation products of independent magmas. They are described as containing orthoclase-mantled labradorite and the more acid members —shoshonite and banakite—have a chemical composition which is comparable with that of the Milton rock. An analysis of banakite is quoted in Column vi of the table of analyses.

Mr. G. W. Card (Jaquet, Card and Harper, 1905-9, p. 14) recognized the possible affinities of this Series with the Bumbo Flow, although at the time no specimens from the Absaroka Range were available for direct comparison in Sydney. Since then type specimens have been obtained from the U.S. Geological Survey by Mr. Card, who has kindly allowed the writer to examine these specimens.

A specimen of banakite from near Beaver Dam Creek, Absaroka Range, is similar to the fine-grained variety of the Milton rock and a specimen of shoshonite, from a dyke in Crandall Basin, Absaroka Range, which is considerably albitized, may be compared with the medium-grained rock outcropping at Little Forest, west of Milton.

Following the classification set out by Iddings, it seems that the fine-grained Milton rock is a "latite", understanding the term to mean a fine-grained rock, chemically equivalent to the monzonites.

The special variety of latite known as "banakite" is defined by Iddings (1913, p. 189) as being "dark coloured, with phenocrysts of plagioclase, labradorite and augite with some serpentinized olivine. The groundmass consists of plagioclase prismoids with outer shells of orthoclase, besides augite, iron oxides, a small amount of apatite, and some zeolites".

This description agrees so well with that of the fine-grained phase of the Milton rock, that the adoption of the name "banakite" for this type is considered to be amply justified.

F. *Albitization and Kindred Phenomena.*

The process of albitization appears to have been of magmatic origin, for it has affected chiefly those rocks which were the last to crystallize, the segregation-veins of monzonite-pegmatite and monzonite-aplite, and the adjacent coarse-grained phase of the monzonite itself. The finer-grained varieties of the monzonite are practically free of the effects of these "deuteric" (Sederholm, 1916) processes.

Bailey and Grabham (1909) have described the albitization of basic plagioclase in Carboniferous lavas, and Permo-Carboniferous intrusions in Scotland and the north of England, and attribute the formation of albite to the action of juvenile solutions, which have produced also chlorite, calcite and small quantities of zeolite.

According to Holmes (1920) the term "albitization" is applied only to the replacement of basic plagioclase by albite, due to paulopost juvenile action, but it seems necessary to extend the meaning of the term, so as to include the replacement of original orthoclase by albite, for this is a conspicuous feature of the albitized rocks at Milton. The albitization of orthoclase has been observed also in Carboniferous rocks of the Hunter District (Osborne, 1925, p. 115).

Kaolinization has accompanied the formation of albite, in such a way as to leave no doubt of its magmatic origin. The relatively light colour of the albitized rocks is due largely to the presence of kaolin. A large amount of chloritic material is found in association with the albite. It sometimes replaces felspar, but principally occurs interstitially with respect to the felspars, behaving like an original product of consolidation of the magma. Small quantities of calcite and zeolites are found in the pegmatite veins. Their mode of occurrence indicates that usually they are of deuteric origin, but in one case the radiating zeolite may have been produced as the result of atmospheric weathering.

The alteration of olivine to serpentinous material (most pronounced in those rocks in the vicinity of the segregation veins) is possibly "late-magmatic" in part (Benson, 1918) and the occurrence of large needles of apatite in the coarser phases of the monzonite suggests that this mineral may have been held in solution until late in the cooling history of the magma.

G. *The History of the Intrusion.*

There are certain peculiarities in the association of rock types previously described, which require some comment and explanation. The normal monzonite contains a small amount of olivine: through it are segregation veins of pegmatite, which are free of olivine, but which contain a little analcite, as well as some prehnite and calcite. The normal rock is also cut by narrow veins of an acid quartz-felspar rock, and encloses spherical masses of a rock mineralogically similar, but somewhat different in texture. There are no sharply defined boundaries to the veins, which appear to have been formed before the complete consolidation of the monzonite, with which they are probably comagmatic; the actual boundaries of the spherical inclusions could not be examined on account of weathering.

This association of evidently related rock-types could scarcely have resulted from crystallization-differentiation *in situ*, but is most probably due to separation in an intercrustal reservoir.

Possibly the differentiation of a monzonitic magma in a magma reservoir, by liquidation or otherwise, resulted in the separation of a basic and an acid fraction, with the subsequent injection of the basic differentiate into the Upper Marine strata, in the form of an irregular laccolite, with associated sills. The smaller intrusions and the marginal portion of the main mass cooled rapidly to a fine-grained basaltic rock, banakite, whilst those portions more remote from the cooling surface, crystallized more slowly to monzonite porphyry and a variety of monzonite having essentially the same chemical composition as the banakite.

The later stages of consolidation were accompanied by the development of cracks, into which the residual magma was squeezed, resulting in the formation of monzonite-pegmatite and monzonite-aplite veins.

During the course of injection, masses of the more acid material were caught up in the monzonitic magma, and these are represented by the acid "kernels".

At a later stage in the cooling of the monzonite, other portions of the more acid differentiate were injected into cracks, forming the aplite veins.

Magmatic waters subsequently caused the alteration of the felspars to albite and kaolin, and of the olivine to serpentinous material, with the deposition of interstitial, chloritic material and small quantities of zeolites and calcite.

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Appended Note on the Rocks outcropping at Woodburn and Murramarang.

Specimens of rocks outcropping about 15 to 20 miles south of Milton, have been described by Mr. G. W. Card (Harper, 1915, p. 313) who quotes two chemical analyses of these rocks.

In chemical composition, the rocks are slightly more basic than the Milton rocks, with a higher content of lime and magnesia, and slightly lower alkalis,

but on the whole the analyses indicate that these rocks are comagmatic with those of the Milton District.

Specimens of the Woodburn rock collected by the present writer and rather fresher than those available to Mr. Card, show phenocrysts of tabular labradorite surrounded by a definite zone of orthoclase, with a large amount of augite and olivine in a groundmass of felspar, augite, apatite, iron ore and accessory biotite.

To the northeast of the main intrusion at Woodburn, there is an outcrop of a fine-grained basaltic rock, not previously recorded, which appears to be identical with the banakite at Milton.

Due east of Woodburn, a dyke over one hundred feet in width, striking east and west, cuts through the Ulladulla Mudstones exposed on the coastal rock-platform a little south of the entrance to Burrill Lake. It consists of rock similar to that at Woodburn.

The rock outcropping at Bawley Point and Murramarang is much more coarsely crystalline than any other rock in the district. It consists of very abundant grains of greenish augite, as much as 3 mm. in diameter, with orthoclase-mantled labradorite, some olivine, apatite and magnetite.

No trace of nepheline could be found, but in places the rock is albitized, and a certain amount of interstitial analcite is developed.

The rock is best described as an essexite, with affinities to kentallenite and olivine-monzonite.

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GEOLOGICAL SKETCH MAP

OF THE

MILTON DISTRICT

COUNTY OF ST. VINCENT

Partly based on Maps published by the Department of Mines. N. S. Wales.

PARISH OF LITTLE FOREST

CONJOLA CREEK

CONJOLA

TO NOWRA

BUNNAIR CREEK

PARISH OF CONJOLA

PRINCES HIGHWAY

CONJOLA LAKE

Red Head

Cunjurong Point

Green Island

OCEAN

SOUTH PACIFIC

YATTAH FALLS

CURRAMBAR CREEK

YATTEYATTAH

THE POINTER

CLIFFS OF LITTLE FOREST

CONJOLA

NARRAWALLEE CREEK

YACKENGARRAH CREEK

LITTLE FOREST TRIG 1829'

LITTLE FOREST CREEK

LITTLE FOREST

WALL

TIDAL LIMIT

BRIDGE

MILTON TRIG 316'

STONY HILL

CROOBYAR CREEK

MILTON

Bannister Head

PARISH OF CROOBYAR

BRIDGE

BURRILL CREEK

ULLADULLA

North Head

ULLADULLA HARBOUR

WARDEN TRIG 79'

Warden Head

WOODSTOCK

ULLADULLA

BURRILL LAKE

TO TERMEIL

PRINCES HIGHWAY

PARISH OF WOODBURN

TO MORUYA

I. A. B. delt

Magnetic North

SCALE

80 60 40 20 0 80 160 CHAINS

1 ½ ¼ ¼ 0 1 2 MILES

LEGEND

CAINOZOIC
- RECENT — *Alluvium*
- TERTIARY — *Basalt*

PALAEOZOIC
- PERMOCARBONIFEROUS
  - *Monzonite Porphyry*
  - UPPER MARINE
    - *Nowra Grits*
    - *Conjola Conglomerates*
    - *Ulladulla Mudstones*
- DEVONIAN — *Granite*
- *Slates*

Approximate Positions of Silica Workings S

Boundaries : Parish —·— *Geological* -----

1

2

3

1, 2. Views of the Milton District. 3. Yattah Falls.

NATIONAL MUSEUM
VICTORIA

Rocks from the Milton District.

NATIONAL MUSEUM
VICTORIA

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EXPLANATION OF PLATES XLIV-XLVI.

Plate xliv.

Geological Sketch Map of the Milton District.

Plate xlv.

1 and 2. Typical views of the Milton District.

3. The Yattah Falls. Banakite resting on horizontally bedded sedimentary rocks of the Nowra Stage, Upper Marine Series.

Plate xlvi.

1.—Monzonite, showing portion of a large crystal of labradorite surrounded by a zone of orthoclase, which appears white. Crossed nicols. Magnified 15 diameters.

2.—Monzonite, showing a large needle of apatite with a central core of chloritic material, and also zoned felspars. Crossed nicols. Magnified 30 diameters.

3.—Group of felspar phenocrysts and pseudomorphs after olivine in the monzonite-porphyry. Crossed nicols. Magnified 30 diameters.

4.—Typical Banakite. Some of the labradorite phenocrysts have a very narrow mantle of orthoclase. Crossed nicols. Magnified 13 diameters.

5.—Albitized Monzonite showing the replacement of orthoclase and labradorite by albite, and also interstitial chloritic material. Crossed nicols. Magnified 11 diameters.

6.—Aplite showing albitized and kaolinized orthoclase with interstitial quartz. Crossed nicols. Magnified 30 diameters.

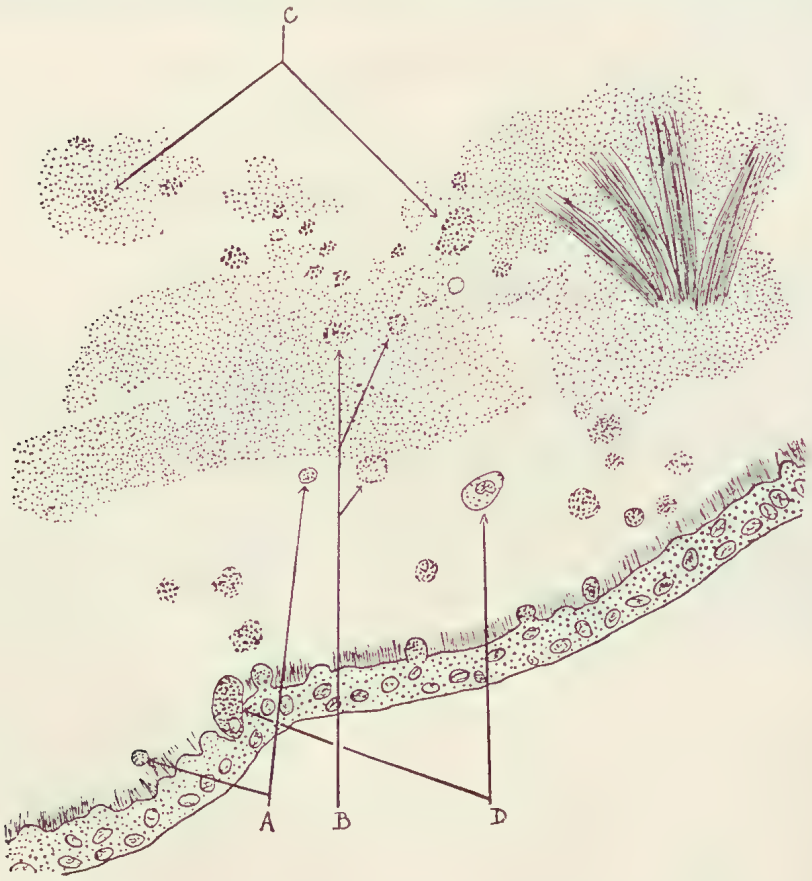
A NOTE ON AN UNUSUAL TYPE OF SECRETING EPITHELIUM IN THE WOLFFIAN DUCT OF THE MALE DOG-FISH (*SCYLLIORHINUS CANICULA*).

By P. D. F. Murray, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

Four Text-figures.

[Read 28th October, 1925.]

While investigating the histology of the reproductive duct of an hermaphrodite dog-fish (Murray and Baker, 1924*), a curious type of secreting epithelium was noticed lining the Wolffian ducts of the normal male fish, both in the vas deferens,



Text-fig. 1.—From a transverse section of Wolffian Duct between mesonephros and vesiculum seminalis. Watson Apo. 8 mm. and Watson Holos. × 14. (× 400.)

* *Journ. Anat.*, lviii, 1924.

and in the region known as the vesiculum seminalis. This is a ciliated epithelium one or two cells thick, the cells being of a low columnar form. Cell outlines are difficult to see in the material examined, but that the epithelium is made up of discrete cells and is not a syncytium is shown by the fact that in places the cell outlines are visible, as in part of Text-figure 4.

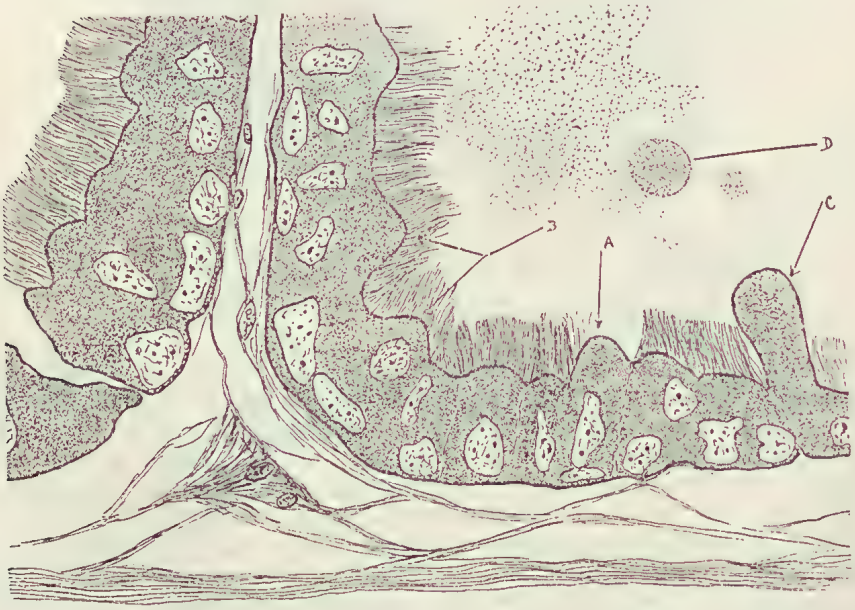
The epithelium consists mainly of cells bearing long cilia, but scattered among these are other cells, which bear no cilia, and whose function is secretory. The appearance of these cells varies according to the stage in the secretory process which has been attained by the individual cells. Further, there appear to be two modes of formation of the secretion. The secretory cells project somewhat beyond the level of the general ciliated epithelium, and those which are about to give off their secretion have their free ends rounded into spherical projections. These knob-like projections take the stain (Ehrlich's Haematoxylin and Eosin) more deeply than do the cell-bodies proper, but in texture they appear to be precisely similar to the rest of the cell, except that they are perhaps a little more dense.

Text-fig. 2.—From a transverse section of the vesiculum seminalis region of the Wolffian Duct, showing three secreting cells and some of the ciliated epithelium. Zeiss $^{1}/_{12}$ inch and Watson Holos. × 10. (× 1600.)

Now, if the contents of the duct be examined, it will be found to consist of a homogeneous or finely granular substance, which in life is doubtless fluid, with many bundles of spermatozoa embedded in it. There will also be found embedded in it many small spherical bodies which are easily identified as the cast-off spherical projections of the secretory cells of the epithelium, since all stages can be found between the recently cast-off intact sphere (Text-fig. 1, *a* and 4, *d*), through such stages as are shown in Text-fig. 1, *b*, where the knobs are seen beginning to disintegrate, to stages like Text-fig. 1, *c*, where the well defined rounded outline of the sphere has been lost, and it is scarcely distinguishable from the general mass of the substance in which the bundles of spermatozoa lie. There can, then, be no doubt that the spherical projections of these cells form, by their disintegration, the material in which the spermatozoa are bathed. The natural assumption is that this substance is a nutrient medium, analogous to

the seminal fluid of man, and the histological appearance strongly supports the idea that the spherical bodies are actual protruded portions of cytoplasm, rather than globules of a metaplastic secretion. This is made more probable by the existence of what appears to be another mode of formation of the secretion. In

Text-fig. 3.—From a transverse section of the vesiculum seminalis region of the Wolffian Duct showing a secretory cell with the sphere in a more advanced stage than in Text-fig. 2. Zeiss $^{1}/_{12}$ and Watson Holos. × 10. (× 1600.)



Text-fig. 4.—From a transverse section of the vesiculum seminalis region of the Wolffian Duct, showing ciliated epithelium, secretory cell probably about to leave the epithelium, and the base of one of the longitudinal ridges of the duct wall. Zeiss $^{1}/_{12}$ and Watson Parachromatic No. 2 (× 6). (× 700.)

this, whole cells are extruded from the epithelium and come to lie free in the lumen of the duct, where they would appear to degenerate and contribute to the secretion. Such cells are shown at *d* (Text-fig. 1), and the cell at *c* (Text-fig. 4) appears to be about to leave the epithelium.

Turning to the figures, Text-fig. 3 shows a cell with the secretory sphere complete and about to be thrown off, while in Text-fig. 2 three cells in earlier stages of formation of the sphere are seen. At *b* (Text-fig. 4) are shown cells which are either in early stages of sphere formation or else have just thrown off their spheres. These cells are drawn as ciliated. Although this certainly is the appearance presented by the specimen, it is possible that the cilia shown really belong to other cells lying behind those figured. If the cilia are actually upon the cells figured, it suggests that the ciliated cells and the secretory cells are mutually convertible.

I originally noticed this epithelium in collaboration with Mr. John R. Baker, of the University of Oxford, and I am indebted for the material to the Dept. of Zoology in the University of Oxford.

ON THE OCCURRENCE OF PLACENTATION IN THE SCINCID LIZARD *LYGOSOMA ENTRECASTEAUXI*.

By Launcelot Harrison, B.A., B.Sc., Challis Professor, and Hazel C. Weekes.
(*From the Department of Zoology, University of Sydney.*)

(Plates xlvii-xlix and three Text-figures.)

[Read 25th November, 1925.]

Contents.

i. Introductory.
ii. Material and methods.
iii. Anatomical relations.
iv. The Placentae.
v. Comparison with *Chalcides*.
vi. Theoretical considerations.
vii. Summary and Conclusions.

i. *Introductory.*

During the visit of a party from the University of Sydney to Barrington Tops in January and February of this year (1925) under the leadership of the senior author, Dr. I. M. Mackerras, who was examining the reptiles obtained for Haemoprotozoa, discovered that two of the common skinks present, *Lygosoma quoyi* Dum. et Bibr., and *L. entrecasteauxi* D. & B., were viviparous, and were carrying advanced young. In view of the possible interest of this discovery, a series of both species was collected.

The former of these species has already been recorded as viviparous by Lucas and Frost (1893), but these authors state that the latter species is oviparous in Victoria, laying from three to five eggs in January. This suggests a possible difference in reproductive habit on high and low ground, which, should it be confirmed, offers points of curious interest.

The reproductive phenomena of Australian reptiles have attracted small attention from workers in zoology, so that little precise information exists concerning oviparity and viviparity amongst the different groups. Lucas and Le Souef (1909) mention that most of the venomous snakes are viviparous, but quote only two lizards as being so, viz., *Tiliqua nigrolutea* and *Trachysaurus rugosus*, both belonging to the Scincidae. Lucas and Frost (1893) have, however, recorded four other skinks as viviparous. The remaining families of lizards occurring in Australia, viz., Geckonidae, Pygopodidae, Agamidae, and Varanidae are, as far as is at present known, all oviparous. Amongst the skinks, we now know the following species to be viviparous:—

Trachysaurus rugosus Gray	Rec. by Haacke (1885)
Tiliqua scincoides White	„ „ do.
Tiliqua nigrolutea Gray	„ „ Lucas & Le Souef (1909)

Egernia striolata Peters	Rec. by Lucas & Frost (1893)
Lygosoma (Hinulia) quoyi D. & B.	„ „ do.
L. (Siaphos) maccoyi Lucas & Frost	„ „ do.
L. (Liolepisma) pretiosum O'Shaugh.	„ „ do.
and	
Egernia whitei Lacep.	Now recorded from specimens in our collection.
Lygosoma (Liolepisma) entrecasteauxi D. & B.	

It seems likely, when the large Scincid fauna of Australia is adequately examined, that a considerable number of species will prove to be viviparous, since this mode of reproduction offers obvious advantages.

Definite placentation has been recorded only in the case of *Tiliqua scincoides* by Flynn (1923); although Haacke (*l.c.*) mentions certain relations between the uterine wall and that of the yolk-sac in *Trachysaurus rugosus*. Of the nine species mentioned above as being viviparous we have examined pregnant females of five, the first, second, fifth, eighth, and ninth. In *L. entrecasteauxi* alone have we found a definite placenta comparable with that of the classic *Chalcides tridactylus* described by Giacomini (1891). The remaining four exhibit highly vascularized external allantoic and "uterine" walls, with their respective circulations in close apposition, but no marked placental area such as we describe below. The conditions would appear to be much the same as obtain amongst the species of *Chalcides* (Graham Kerr, 1919, p. 480), of which one only has a definite placenta, while in others there is merely close apposition between the maternal and foetal circulations. Since Flynn (1923) has recorded the existence of an allantoplacenta in *Tiliqua*, and has promised a further account of it, we do not propose to do more than draw attention to the fact that in a pregnant *T. scincoides* in our collection, containing young 140 mm. in length, we find neither the villous folding of the uterine wall, nor the great modification of the chorionic epithelium which occurs in the European *Chalcides tridactylus*, and in *Lygosoma entrecasteauxi* as described below.

We have to thank Mr. J. R. Kinghorn, C.M.Z.S., of the Australian Museum, Sydney, for identification of our lizards; Mr. G. Burfield, of the Department of Physiology, University of Sydney, for making the photomicrographs reproduced in Plate xlviii; and Mr. Horace Weekes for the drawings which appear on Plate xlvii.

ii. *Material and Methods.*

The material at our disposal comprises nine pregnant females of *Lygosoma entrecasteauxi* collected at Barrington Tops, 150 miles north of Sydney, at a height of 4,500 to 5,000 feet, during the last fortnight of January and the first week of February, 1925, by various members of the Sydney University Party. The lizards were fixed and preserved entire, after opening up the ventral body-wall to expose the contained foetuses within the uteri, in a fluid recommended by Bles (1905) which has proved to be excellent for general field work, since animals may be preserved in it indefinitely. It has given a good general fixation, which is not, however, in the case of all kinds of cells, good enough for fine histological work. It has, moreover, one serious fault in that it renders tissues very brittle, and so makes difficult subsequent dissection of material fixed in it.

The embryos examined are all approximately in the same stage of development, 30 to 40 mm. in length, indicating a fairly long gestation period, since

comparatively small differences are shown amongst those collected at random over a period of three weeks. The breeding season would appear, moreover, to be a very regular one, as numerous males were vainly sacrificed in an endeavour to secure younger stages, there being no external differences between the sexes. All the obvious females showed by their bodily contours an advanced condition of pregnancy.

The present communication, then, describes what is practically a single stage, and that much too advanced for the satisfactory elucidation of the earlier ontogenetic features, which should prove of considerable theoretical interest. The authors will endeavour to obtain a series of earlier stages during the coming summer, but have thought it advisable, in view of the interest attaching to the discovery of a second fairly complex allantoplacenta in the Scincidae, to publish the description which follows of the actual placental condition, hoping to be able on a future occasion to give some account of its development.

Examination was made by means of whole mounts of both foetal and maternal placentae, and of the two together; and by means of paraffin sections of the conjoint placental area alone, and of the whole uterine sac with its contained embryo, taken transversely to the long axis of both oviduct and foetus. All preparations were stained with Ehrlich's haematoxylin, eosin being used as a counterstain for the sections.

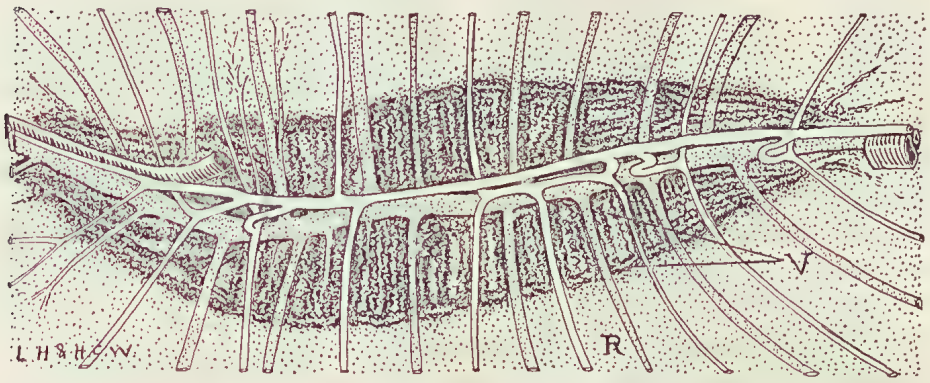
iii. *Anatomical Relations.*

Of the nine pregnant females available, two contained seven young, five others five each, and the remaining two only three. It seems remarkable that the number should be odd in every one of nine examples, and we cannot find any explanation for this condition. It is obvious, when large young are produced in a small parent, that these must be somewhat finely adjusted to the space available for their development. One would therefore expect the row of embryos contained in one oviduct to alternate with those contained in the other, and this is found to be so. Moreover, those lizards which contain three young are the smallest of our specimens, but size does not appear to offer any explanation in regard to the five individuals which have five contained young, since, if size were a factor, there is sufficient variation amongst them to lead one to expect four young in one case and six in another.

The number of embryos in either oviduct seems a matter of chance. From three of our specimens the embryos had been removed for dissection and sectioning without a note having been taken of their positions. Of the remaining six, four had more embryos in the right oviduct than in the left. The contained foetuses in our specimens are all well advanced, and approaching full term. We have selected for examination what appears to be the youngest stage present, in which we find the foetus to be 26 mm. in total length when extended; as well as several older stages, in which the average total length is 33 mm. There is, therefore, not much difference between our youngest and oldest stages. The embryos within their membranes cause the oviducts to exhibit a series of moniliform swellings (Pl. xlvii, fig. 1) very closely adpressed end to end, so that they adjoin by flat surfaces, and are connected one to another by a short, strap-like section of the oviduct which joins the centres of these apposed surfaces. These swellings are called by Giacomini for *Chalcides* "incubatory chambers", but we use the term "uterus" for the whole uterine portion of the oviduct, which must have become greatly distended from its original condition, since the small ovaries lie on its mesial border at the middle of its length, and not anteriorly. Mutual pressure of

the embryos contained in the two uteri brings about a flattening of their mesial faces also. Each swelling is thus roughly oblong in surface view, with an average length of 6 mm., by 9 mm. wide.

Certain structures are more or less visible through the thin and much distended uterine wall. As the parent lies upon her back, with the ventral body-wall opened up, and the uteri exposed, the region of the yolk-sac for each embryo shows as a creamy area, ventral and lateral, i.e., anti-mesometrial in position. On turning back the uterus of either side, the allantoplacental region is seen to be dorsal and mesial, and the maternal placental area shows as an opaque patch (Pl. xlvii, fig. 1) plainly visible to the unaided eye.



Text-fig. 1.—Placental area of uterine wall viewed as a transparent object. Arteries white, veins stippled; R, area shown in Text-fig. 2*a*; V, villous ridges; × *circ.* 12 diameters.

The series of prominent blood vessels, arteries and veins parallel and, in general, alternate, which runs out from this area round the uterine wall (Pl. xlvii and xlviii, fig. 1; Text-fig. 1) stops at the margin of the yolk-sac, and so helps to delimit the boundaries of the latter. The foetus lies with its long axis parallel to that of the parent, and with the yolk-sac upon its left, and the main portion of the allantoic cavity upon its right side. It is thus in an obliquely vertical position, lying upon its back, with its head curled up towards the dorsal side of the parent body, and directed anteriorly when in the left uterus, posteriorly when in the right. The tail is folded forwards over the ventral surface of the foetal body as far as the head, close to which it turns inwards and ends in a close spiral. The same general relations hold for all our specimens with the exception of one in which the yolk-sac area is distinctly more mesial in position.

On dissecting away the uterine wall, and disclosing the foetus lying within its membranes, it is at once obvious that the allantoic sac does not completely surround the whole periphery, but turns inwards round the edge of the yolk-sac and passes internal to the latter structure. Externally, the yolk-sac is covered only by the serosa. It is, at the stage we discuss, apparently much reduced, and extends over only about one-fourth of the circumference of the "blastocyst" in section, the remaining three-fourths being occupied by the allantois. The yolk-sac is mushroom-shaped, the stalk ascending to meet the allantoic stalk in a common umbilical stalk close to the mid-line of the foetal body at a little distance in front of its hind limbs. The relations may be seen at a glance by reference

to the stereogram reproduced as Figure 3 of Plate xlvii. By reference to the same figure, the allantoic stalk is seen to pass directly upwards and to open out, above the embryo, into a wide allantoic cavity which passes round the foetus in all directions to extend, at the lower pole, inwards between it and the yolk-sac, ending, in a ring-like manner, around, but quite free from, the yolk-stalk at its junction with the sac.

To the amnion we have not given any particular attention. It is an extremely delicate membrane, which arises from round the base of the umbilical stalk, and closely invests the foetus through all its curvatures. We can find no trace, at this stage, of a sero-amniotic connection.

There is no trace of egg-shell or of secondary membranes apparent in our stages, nor can we determine the origin of a coagulum which lies between the uterine wall and the serous membrane in the yolk-sac region (Pl. xlviii, fig. 4; Pl. xlix, fig. 3), which may be the remains of albumen, or may be a uterine secretion.

iv. *The Placentae.*

Lygosoma entrecasteauxi possesses both an omphaloplacenta and an allantoplacenta, the latter being much more highly organized in the stages at our disposal. The arrangement of the blood-vessels in the uterine wall (Pl. xlviii, fig. 1, and Text-fig. 1) suggests that possibly the yolk-sac placenta was more important at an earlier stage. These vessels are so very prominent, and end so suddenly at the periphery of the area of uterine wall overlying the yolk-sac, entering into small relations with the sparse vessels of this region, that the arrangement suggests a change-over from an earlier and more richly vascular omphaloplacenta to a later allantoplacenta. We find in *Lygosoma quoyi* that the maternal portion of the omphaloplacenta is very richly vascular. In this form, as far as our observations have gone, there is no definite allantoplacenta, and the yolk-sac placenta is very prominent in stages seemingly equivalent to those of *L. entrecasteauxi* which we have examined, so that the two are not strictly comparable. In *Chalcides*, according to Giacomini (1891, p. 356), the yolk-sac placenta "se developpe tardivement et reste rudimentaire".

(*a*) *Maternal blood-circulation.*—We reserve a full statement of the details of maternal circulation for a future occasion, when we shall have earlier developmental stages for examination and comparison. Here we give merely a brief outline of the arrangement of vessels in the uterine wall. A large artery and vein run longitudinally on the dorsal side of the uterus, slung in a fold of the mesometrium, and standing out as a prominent ridge bisecting the allantoplacental areas (Pl. xlvii, fig. 1, *Ut. b. v.*). The vein receives a single large branch vein from each placental area, to which latter the artery sends also a single branch. The placental artery runs dorsal to the vein, and branches in a manner best seen by reference to Text-fig. 1, which shows a series of paired branches running parallel with one another transversely round the uterus. The placental vein is branched in a somewhat similar fashion, the branch veins in general alternating with the branch arteries. Arteries and veins extend to the periphery of the yolk-sac area, as mentioned above. The arteries give off frequent minute branches to the capillary network of the uterine wall, which is extraordinarily rich, and ramifies as a close plexus over the whole of its area (Text-fig. 2, *a*). From this reticulum small vessels enter the branch veins, and are carried back to the main placental vein. Over the yolk-sac area there remain only a few small irregularly ramifying vessels. The maternal portion of the allantoplacenta appears as a fusiform to

elliptical opaque whitish area (Pl. xlvii, fig. 1, *Plac.*), the opacity being due to the fact that the internal face is raised up into a series of villous ridges, covered by a cubical epithelium, and containing otherwise only capillary blood-vessels with their endothelial lining. At either end of the placenta these ridges run in a general longitudinal direction, but in the middle region, for about half its length, they are arranged transversely. Each apparent major ridge is formed by the

Text-fig. 2.—(*a*) Vascular reticulum in uterine wall in optical section; (*b*) Uterine villous fold in optical section.

closely sinuous plaiting of a much narrower fold, the whole having a very complex form. The vessels occupying these ridges are fed by short branches from the main branch arteries and veins. A prominent ridge runs round the periphery of the whole area. The nature of these ridges is shown in Text-figure 2, *b*; and some idea of their complexity may be gained by reference to the section reproduced as Figure 3 of Plate xlviii.

(*b*) *Foetal blood-circulation.*—A section of the umbilical stalk is shown in Plate xlix, figure 6, from which it will be seen that the endodermal lining surrounds a simple cavity, formed by the junction of the yolk-sac and the allantoic stalks, which passes into the body of the foetus, and runs posteriorly for some considerable distance before entering the gut. The splanchnopleural mesoderm is thrown into somewhat intricate folds, wrapping round the various blood-vessels. Close to the body, the dorsal space surrounded by these folds is filled with proliferated mesenchyme, surrounding the umbilical and vitelline veins, which are both single, and one of the paired vitelline arteries. An umbilical artery, formed by the junction of two distinct arteries in the allantoic stalk (see Pl. xlix, fig. 5), and the other vitelline artery lie on the ventral side of the stalk lumen. When these vessels are traced into the body of the embryo, the umbilical vein enters the liver, and there joins with the intra-hepatic vessels, and with the ductus venosus; the umbilical artery is found to branch from the aorta posteriorly, and not from the sciatic artery as in the chick; the vitelline vein enters the liver; and the two vitelline arteries are given off separately from the aorta. As the yolk-stalk is followed outwards, it is seen that a second and smaller vitelline vein enters the umbilical vein.

As the allantoic stalk passes upwards, the umbilical artery divides into two branches, which come to lie on either side of the umbilical vein. When the

allantoic stalk opens out into the sac, the blood vessels are carried across the lumen of the latter in a remarkable and interesting manner direct to the placental region. In three of the four embryos of which we have serial sections, a pleated fold arises from the inner allantoic wall (Pl. xlvii, fig. 3; xlviii, fig. 2; xlix, fig. 5, *Pl.*), within the inner free edge of which the vessels are carried. Since this pleat is covered externally with endoderm continuous with that lining the allantoic cavity, there would appear to be no doubt that it has arisen originally as a fold of the allantoic wall. The base of this fold is of considerable extent, and can be traced round the inner wall of the allantois almost to the yolk-sac region. Figure 5 of Plate xlix shows clearly enough the way in which the vessels link up; and in the photomicrograph which appears as Figure 2 of Plate xlviii the umbilical vein is shown actually in transition to the placental region. In our fourth series of sections a somewhat different condition occurs. In place of the flat fold, a blunt finger-like process is pushed out from the inner wall, and passes across the lumen to bring about the same ultimate result. Since the fold occurred in three embryos which were dissected (and puzzled us considerably until sections disclosed its actual nature) as well as in three sectioned embryos, it would appear to form the normal method of transference.

Flynn (1923, p. 77, and Fig. 1, p. 74) describes and figures for *Tiliqua scincoides* a somewhat similar arrangement. He writes:—"But the outer wall of the vesicle is also supplied by vessels which leave the allantoic stalk near the body of the embryo, and pass right across the vesicle to ramify through the mesenchymal layer of the placental face of the allantois. The presence of such a method of transmission of allantoic vessels—by direct cellular bridges across the allantoic cavity—is interesting in that it has already been recorded by Hubrecht for a monodelphian mammal, *viz.*, *Erinaceus*". Flynn figures the allantoic stalk as passing down posterior to and parallel with the yolk-stalk, but his "cellular bridge" offers so close an analogy with the allantoic stalk of *Lygosoma entrecasteauxi*, and with its continuation as the edge of a pleated fold, that we suspect further examination will prove the relations to be the same in both forms. In any event, the condition shown by *Lygosoma* has nothing in common with that described by Hubrecht for the hedgehog.

(c) *The omphaloplacenta.*—This structure is obviously in a condition of regression, and it would serve no purpose to discuss in any detail the scarcely different stages which we possess. In Figures 4 and 5 of Plate xlviii, the general relations of our extreme stages are shown. The yolk-sac is more voluminous in the latter than in the former, and contains a homogeneous coagulum within portion of its cavity, which resembles generally that found lying between the serosa and the uterine wall in the former, which is shown in more detail in Figure 3 of Plate xlix. Since this coagulum stains deeply with haematoxylin, it differs altogether from that found in the allantoplacental region, which remains practically colourless. Possibly this coagulum represents the remains of an albuminous coat, but it seems more likely that it is some trophic secretion of the uterine wall, which has gravitated to the bottom of the cavity after fixation.

The uterine epithelium is here cubical, the cells measuring on an average .028 mm. in height by .016 to .022 mm. in width, which is approximately the same size as those covering the villous ridges of the allantoplacenta, and greatly larger than those of the intermediate area. The epithelium is underlain by a network of small capillaries, which here and there appear to cause slight bulges of the overlying cells, but no folding into ridges can be seen.

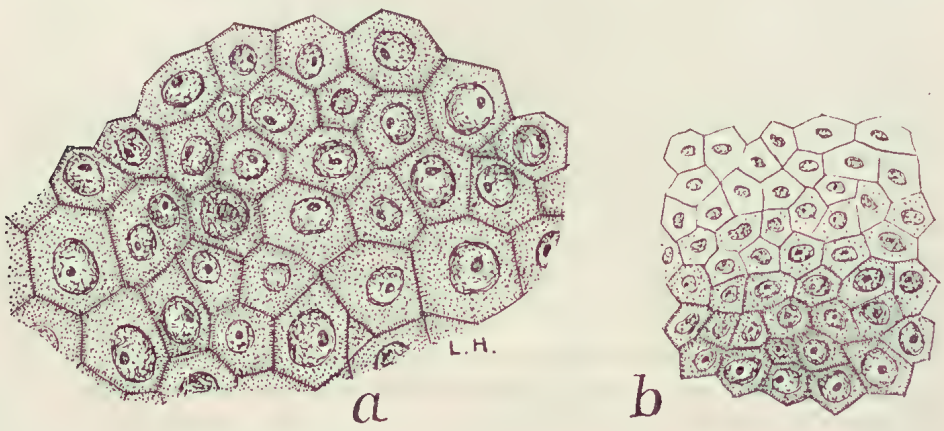
The chorion consists of an ectodermal layer of cubical cells measuring .03 mm. in height and width, bounded internally by a narrow layer of mesoderm. The endodermal cells of the yolk-sac itself are relatively enormous, measuring .124 mm. in height by .05 mm. in breadth. Their general form is indicated in Figure 4 of Plate xlix. They show large, densely-staining nuclei, and the cytoplasm is extensively vacuolated, and is packed to a varying extent with large yolk sphaerules.

(*d*) *The allantoplacenta.*—The general disposition of the maternal portion of this organ has already been dealt with in the description above of the maternal circulation. The thickened and plaited area which is clearly delimited by a ridge running round its margin, measures 10 mm. long by a little more than 3 mm. wide in the example figured (Text-fig. 1; Pl. xlviii, fig. 1). The thickened chorionic epithelium which characterizes the foetal portion of the placenta is of slightly greater extent, its margin passing that of the maternal area right round the periphery. The way in which the inner face of the uterine wall is folded leaves a series of crypts lying between the complicated villous ridges. There is, however, no interpenetration of chorionic ectoderm into these crypts, maternal and foetal layers being closely apposed, so that the general form of the villous ridges impresses itself upon the chorionic surface, but without any kind of fusion whatever. However carefully the placental area is dissected away, the maternal and foetal membranes at once become free from one another, and a certain degree of separation follows upon careful embedding and sectioning of the whole blastocyst within its uterine chamber. Reference to Figure 2, Plate xlviii will show this separation, as well as the fact that the sectional outline of the maternal villi is complementary to that of the foetal chorionic ectoderm. Drawings made by means of the camera lucida, cut out in profile and then apposed, have shown that the two membranes fit closely together. Flynn (1923, p. 76) describes the connection between these epithelia in *Tiliqua* as very intimate, and suggests a certain degree of plasmodium formation, and of interpenetration of foetal cells between those of the uterine wall. Our photographs and drawings show conclusively that such things do not occur in *Lygosoma*. We have to do simply with two epithelial sheets with every cell clearly bounded, which are in a position of close apposition, but are in no way joined or fused, nor do they exhibit amoeboid processes or plasmodium formation. Certain portions of the photomicrograph which forms Figure 3 of Plate xlviii might perhaps be interpreted as suggesting this last, but examination of the actual sections shows that these represent sections of villi cut tangentially.

The maternal crypts thus form chinks or interstices between the two membranes, and are for the most part filled with a ropy, non-staining coagulum which, as already mentioned, differs from those found in the yolk-sac region. The villous ridges project on an average .1 mm. from the uterine wall. The cells of the epithelium covering them measure in section .025 mm. by .017 mm. At the edges of the placental area there is no transition of this thickened epithelium into the squamous type which lines the uterus, as occurs in the foetal ectoderm. The epithelium is strongly ciliated, and the last lateral thickened and ciliated cells of either side of any section adjoin a non-ciliated squamous cell of the general surface. The cells have a densely granular, dark-staining cytoplasm, but show no signs of vacuolization, or of glandular activity. No specialized glands occur over the area.

The cells of the chorionic ectoderm are columnar and extremely elongated, being in all cases twice as long as broad, while cells occur quite frequently which

are three times as long as broad. The free surfaces are mammillate in form with a dark border in section and strongly ciliated. The whole of the cytoplasm is densely granular and shows little sign of vacuolization. The nuclei are large and vesicular, in many cases occupying almost the whole width of the cell; most of them show one large densely staining nucleolus, central or slightly eccentric in position, but in some there are two nucleoli placed at opposite poles. No signs of active multiplication are apparent in the form of mitotic figures, but this is possibly due to the slowness of fixation since some cells show two small nuclei closely apposed to one another along the long axis of the cell while here and there two extremely narrow cells with their nuclei side by side suggest recent division, in which the cell has not yet grown to its maximum size. The outline of the free surface of this epithelium in section is very irregular and consists of a succession of bays and prominences which correspond to the prominences formed by the uterine villous ridges of the maternal placenta. The extent of thickened ectoderm slightly exceeds that of the maternal placental area, but peripherally there is a marked flattening out of the epithelium until at the margin of the foetal placenta the cells are absolutely cubical and only about one-quarter the height of those of the middle of the placental region. These cubical cells have densely staining nuclei right at their bases and exhibit a very definite border of denser material which stands out clearly from the remainder of the cytoplasm. Passing beyond the margin of the placental region the chorionic ectoderm becomes squamous, and the cytoplasm loses its granular appearance and the nuclei their vesicular form, the latter becoming ellipsoid in shape and staining very densely and uniformly (Text-fig. 3, *b*).



Text-fig. 3.—Chorionic ectoderm in surface view; (*a*) in middle of foetal placenta; (*b*) transition zone at edge of same.

The somatopleural mesoderm has throughout most of the placental region a fairly complex structure. The main vascular network lies close at the base of the chorionic cells, so much so that in transverse section the extremely numerous capillary vessels have the appearance of piercing the cell bases. These minute vessels appear in all cases to have endothelial lining, the lumen being surrounded by an extremely fine but quite definite membrane, which is frequently enlarged to surround sickle-shaped nuclei which are curved round the narrow lumen of the vessel. Internal to these capillaries lies a definite cellular membrane with

flattened nuclei lying parallel to the bases of the ectodermal cells. Internal to this is a sheet of mesenchymatous connective tissue, thin over the greater part of the placental region but forming a fairly thick cushion from the caudal end, commencing where the allantoic vessels crossing the cavity attach themselves to the placental region, and running round in the direction of the yolk-sac. This tissue consists of a loose reticulum containing scattered nuclei, and is bounded internally, by a second endothelial layer. Through this connective tissue, throughout most of its extent, there runs a thin sheet of muscle fibres.

v. *Comparison with* Chalcides.

The literature of placentation in *Chalcides* is not very voluminous, and is, apparently, confined to a period of about five years following upon Giacomini's original announcement in 1891. We quote below (p. 485) a number of titles having reference to it, but most of these papers, unfortunately, do not appear to be available in Australia, and we have had access to two only of Giacomini's papers, viz. what is apparently a reprint of his original account in the *Monitore zoologico italiano* which appears in the *Archives Italiennes de Biologie*, Vol. xvi, for 1891; and a brief summary of his results in the *Anatomischer Anzeiger* for the same year. Lesser references to his results occur in Strahl (1891), Kerr (1919), and Schauinsland (1906).

In *Chalcides*, apparently in the vicinity of Sienna, although this is not definitely stated, ripe ova from 2.5 to 3 mm. in diameter descend into the oviduct about the middle of May, and are there fertilized. Neither an albuminous layer nor secondary membranes are formed about them. They differ from those of oviparous reptiles in the small yolk content. The young are born, free from foetal envelopes, at a length of 95 mm., after a gestation period of three months. The number of ova varies between 5 and 15, the average being 8 to 10, but all do not necessarily develop. The ova become spaced out in the oviducts, producing ultimately moniliform swellings which persist for some time after birth. The ova lie with their animal pole mesometrial in position. The embryo lies transversely to the long axis of the blastocyst, upon its left side on the yolk-sac, with the allantois, when first developed, upon its right side. The latter grows down ventrally, but never passes round the yolk-sac externally, that is to say, between it and the serosa. The placental area is elliptical, the villous ridges of the uterine wall running in the general direction of the long axis of the ellipse. The chorio-allantoic membrane shows ridges corresponding to the "crypts" in the uterine wall, but there is no close interlocking between the two membranes, which are easily separable, and between which interstices filled with coagulum occur. The coagulum is stated to be the product of the thickened epithelium covering the uterine villi, and may be in part produced by the cytolysis of proliferated cells, but this is not certain. The blood circulation is not described in detail, but it is mentioned that the vascular network of the foetal is richer than that of the maternal placenta, so much so that in places on the peripheral region the meshes surround only one or two epithelial cells.

An omphaloplacenta precedes the allantoplacenta, but is not very highly developed, and is marked chiefly by the persistence of thickened chorionic ectoderm in this region. The chorionic ectoderm of the allantoplacental region is uniformly and strongly thickened, much more so than in the yolk-sac region, the cells being narrow and very high, with granular contents. This epithelium is thrown into villosities, which correspond to the "crypts" in the uterine wall, and the

bases of these villi are underlain by a rich vascular network, as are those of the uterus.

These last arise before those of the chorion and are, in general, narrower in form. They are occupied internally by a delicate reticular connective tissue, which supports the capillary vessels, and are covered by a simple epithelium of a secretory character, which is much thicker than that lining the non-placental portion of the wall. The cell contents are dark and granular at their bases, becoming light and transparent towards their free faces.

Outside the area of placental modifications, both uterine wall and chorio-allantoic membranes show closely apposed and extremely rich capillary networks. No special description is given of the method by which the allantoic vessels reach the placenta, but from words used (1891, p. 344):—". . . l'allantoïde, en s'étendant dans le cœloma blastodermique ou externe, sous forme d'une vésicule revêtue, intérieurement, par l'entoblaste, et extérieurement par la lame viscérale du mésoblaste (feuillet connectif ou vasculaire de l'allantoïde) dans laquelle courent les vaisseaux allantoïdiens, ne se soit pas encore adossée, par sa face externe ou connective à la face interne de la vésicule séreuse, cependant, cette dernière commence déjà à se pourvoir etc.", it would seem that the vessels pass round the allantoic wall, and are not carried across the cavity by any special contrivance.

We are handicapped in making a comparison between *Chalcides* and *Lygosoma* by the fact that we have not access to the complete descriptions of Giacomini. The figures given in the paper on which we have chiefly to rely illustrate only the external features of the blastocyst. We do not even know whether the Italian embryologist has published figures illustrating the histological relations in *Chalcides*, but the fact that no such figures have been reproduced in any general work known to us seems to imply that none exists. Moreover, we have but one stage, and not a developmental series, for comparison.

Despite these limitations, however, it is possible to make some comparison, and to indicate that the correspondence between the two forms is, in general, remarkably close. *Chalcides* is a larger lizard, producing a greater number of young at a birth. The general relations of the embryo to its membranes are identical, as well as the relations of the foetus to the maternal organs. Both have an omphaloplacenta of the same type, which in *Chalcides* is at no stage very much developed, but in *Lygosoma* seems to indicate a more actively functional condition at an earlier ontogenetic stage. In both, the allantois does not surround the yolk-sac externally; the epithelial lining of the uterine wall changes in character and becomes notably thickened over two placental areas at opposite poles; and the chorionic ectoderm is modified in an apparently identical manner at the same places. In both, the mesodermal elements of the chorion and allantois fuse to form a complex allantochorion, which carries a rich vascular network in correspondence with a similar plexus in the uterine wall, the two being closely apposed. In the allantoplacental region each form shows a series of interstices between foetal and maternal tissues, filled with a coagulum identical in character. Finally the foetal and maternal membranes are easily separable in both, and there is no actual fusion between them.

Lygosoma entrecasteauxi differs from *Chalcides tridactylus* in the following points:—

1. The allantochorion is not thrown into villous folds corresponding to those of the uterine wall.

2. The villous ridges of the latter run chiefly in a transverse direction and not longitudinally.

3. Both uterine and chorionic epithelia are ciliated.

4. The allantoic vessels are carried across the cavity in a special fold of the inner allantoic wall, and do not pass round the periphery of the allantoic sac.

vi. *Theoretical Considerations.*

It is not proposed at this stage to enter upon a detailed discussion of the significance of the reptilian allantoplacenta, but certain outstanding features appear to demand brief comment. The parallelism between the occurrence of a fairly highly-organized placenta in two not very closely related Scincid genera, *Chalcides* and *Lygosoma*, accompanied in each case by indications of simpler placental conditions in related species, is remarkable. Brief references to the placental condition in *Chalcides* are fairly general in text-books, but Graham Kerr (1919) is the only embryologist known to us who has given expression to the importance of this phenomenon, and even he has not discussed its theoretical bearings. In the important discussions of placentation associated with the names of Van Beneden, Hubrecht, Assheton, Jenkinson, and Hill, no consideration has, so far as we are aware, ever been given to the possible value of a reptilian placenta in elucidating the evolutionary history of that organ. Giacomini's original papers are not available to us, but, so far as we are able to judge from the summaries and extracts from which we quote, he himself was fully seized with the importance of his discovery, originally announced much earlier by Studiati, and it is remarkable that his extensive work should have attracted so little attention.

Placentation in Scincid lizards, a specialized family of a specialized group of reptiles, obviously can have no direct genetic relationship with the analagous process in mammals. To our thinking, however, this very fact makes the reptilian placenta so much the more important, for there is here displayed an independent placentation in an otherwise non-placental group, which in many respects affords a very close parallel to mammalian conditions. If the statement of Lucas and Frost quoted above (p. 470) be confirmed, namely that *Lygosoma entrecasteauxi* is oviparous through part of its range, we should have the extraordinarily interesting condition of a species exhibiting in part normal sauropsidan development, and in part a placental mode; but it is probable that this statement rests upon a wrong conception of the contents of the oviducts, such as the same authors have put forward in the case of *Tiliqua scincoides*. Be that as it may, the conclusion seems to us inevitable that placentation is a functional adaptation which, given certain prerequisites, may have arisen independently on many occasions before the higher mammals settled down to the placental mode. These prerequisites comprise (1) an ectodermal layer which has entered into some metabolic relation with the external environment; (2) a yolk-sac; and (3) an allantois.

Without committing ourselves in any way to the view advanced by Hubrecht that the external layer of ectoderm of the anamniote larva is homologous with the mammalian trophoblast, we may justifiably commence an argument from function with this layer. The three prime functions to be provided for in the development of an embryo are respiration, nutrition, and excretion. In the anamniote larva, nutrition is provided for by means of the contained yolk-mass; excretion by the early establishment of archinephric ducts opening into a cloaca; so that the one function remaining to the external cellular layer is that of

respiration. Since we hold the conventional view that the extra-embryonic phenomena exhibited by the amniota are the direct consequence of adaptation to a terrestrial environment, and to the evolution of a shelled egg, we view the extra-embryonic ectoderm primarily as a pneumatoblast, the yolk-sac remaining homologous with the internal yolk-mass of the anamniote larva, and the allantois being a new structure for the reception of poisonous excretory waste. The view we would take of amnion formation was developed before we had studied Hill's work upon the early ontogenetic features of marsupials, but appears to be supported by his observations, which have been confirmed by Hartmann, that there is an early division into formative and non-formative ectoderm, clearly differentiated morphologically, in the marsupial blastocyst. We would suggest that the formative ectoderm, possibly through the assumption of other functions, has lost its primarily pneumatoblastic character, and that it is due to the necessity for a maximum area of respiratory ectoderm that there is rapid proliferation not only in the direction of the yolk-sac, but also, in the form of amniotic folds, above the developing embryo. The extremely rapid proliferation noted by Wilson and Hill in *Ornithorhynchus*, in which the new-laid egg contains already a well-formed embryo, compared with the condition in birds, where the proliferation comes at a much later stage, since the egg at laying is only in an early stage of segmentation, and moreover displays a condition of arrested development, seems to us highly significant in this regard. For us, then, amniotic folds are primarily due to the necessity for a maximum extension of pneumatoblast, and the water-jacket function is secondary. This view, if acceptable, would cut the ground from under Hubrecht's argument that, if the prime purpose of the amniotic cavity be to subserve the function of a water-jacket, it should exist from the outset in a functionally perfect condition. Selenka's view of the mechanical origin of the amniotic folds owing to the downgrowth of the embryo into the yolk-sac is untenable on several grounds, such as the nonoccurrence of these folds in the Elasmobranchs, the absence from them of yolk, the necessity for accounting for proliferation of the edges of the folds, and the backward production of the reptilian amnion far beyond the limits of the embryo. The hypothesis outlined here would have the effect of dividing the nonformative ectoderm into two categories, pneumatoblast and ectodermal lining of the amniotic cavity. This last would, by virtue of its position, lose most, if not all, of its functional significance, and might tend towards elimination in the course of evolution. It seems to us that this suggestion may have a bearing upon the problem of amnion formation amongst the Mammalia.

The yolk-sac we look upon as homologous with the yolk-mass of the anamniote larva, increased in size to permit of the elimination of a larval period, and hence, owing to the mechanical difficulties involved in its enclosure, folded off from the body of the embryo. Since yolk has to be carried to all parts of the body of the embryo, and since blood is the carrier, blood is first formed in the yolk-mass of the anamniote, and in the splanchnopleural mesoderm covering the yolk-sac of the amniote. That is to say, a blood circulation comes into existence upon the yolk-sac to subserve the function of nutrition. Having come into existence, it is available for other purposes. An omphaloplacenta becomes possible by virtue of the existence of a trophic blood-circulation upon the surface of a yolk-sac. Similarly an allantois has come into existence for the reception of excretory waste, and its continually increasing bulk in the sauropsid egg, together with the gradual diminution of the yolk-sac as its contents are absorbed, brings a blood-circulation primarily concerned with the metabolism of its own cellular walls into relation with the external covering of the blastocyst, using the word in its

widest sense, and makes possible an allantoplacenta. These views have been taught, we should suppose, in most schools of zoology for more than a generation, and their reiteration here would be gratuitous were it not for the paradoxical standpoint assumed by so distinguished an embryologist as Hubrecht, obsessed apparently by his preponderant studies of ontogenetic phenomena in the Mammalia.

It may seem presumptuous for workers with small experience in embryology to enter the lists against admitted champions, but we feel strongly that a consideration from the functional rather than from the morphological viewpoint must lead to a clearer understanding of the facts of early ontogeny; and we are of opinion that the independent occurrence of an allantoplacenta in two not very closely related reptiles justifies our functional point of view, and delimits the extent to which the existence of an allantoplacenta may justifiably be used as a phylogenetic argument. Thus the view of Hill (1897), still held by Flynn (1922), that the marsupials must be derived from placental ancestors, rendered inherently improbable by the persistence of the egg-shell in marsupials, becomes, to our thinking, untenable in the light of the fact that two reptiles have developed an allantoplacenta.

We agree with the general statement of Giacomini, who writes (1891, p. 354):—"Le placenta du *Seps* (*Chalcides*) confirme la loi générale établie par Ercolani, Turner, Romiti, et appuyée par Tafani, sur le mode de nutrition des embryons et des fœtus dans l'utérus, puisque les aptitudes à sécréter, constatées dans les élements de la portion maternelle, manifestent que celle-ci, dans certaines, périodes du développement, acquiert la fonction d'élaborer et de fournir un supplément de matériaux nutritifs au nouvel être. C'est pourquoi, ce n'est pas seulement pour les fonctions de la respiration que l'allantoïde, chez le *Seps*, prend, dans une région donnée, après s'être soudée avec la membrane séreuse de von Baer, la forme de placenta allantoïdien, mais bien, spécialement, pour les fonctions de nutrition, ou mieux encore, d'absorption des substances assimilables dont l'œuf fécondé, qui se développe, est dépourvu. Ici également, disais-je, nous trouvons l'unité du processus physiologique qui préside à la nutrition de tous les œufs en voie de développement et qui, même, sert à nous expliquer le pourquoi des dispositions particulières rencontrées dans les annexes fœtales du *Seps*".

We suggest, then, that there are three stages in placentation:—

(i) A *chorioplacenta*, primarily conditioned by the chorionic ectoderm (non-formative ectoderm, trophoblast), in accordance with the view of Minot. This we consider to be first respiratory, though later it may (and does) assume other functions. We have advanced a theoretical argument for its existence. In fact, thickening of the chorionic ectoderm over the embryonic region is well shown in sections of a 4 mm. embryo of *Tiliqua scincoides* in the collection of the Department of Zoology (Fig. 7, Pl. xlix) indicating a very early functional activity for this layer. We do not discriminate between a unilaminar and a bilaminar blastocyst wall, nor concern ourselves with the origin of the underlying lamina where this wall has a double character. The ectoderm is the important thing.

Flynn (1922, p. 541) has suggested an initial stage of placentation by means of the non-vascular wall of the bilaminar omphalopleure, to which he has applied the term "metrioplacenta". The term seems meaningless, and we cannot see that any particular

virtue attaches to this region which is not shared by the ectoderm of the remaining portion of the blastocyst wall.

The chorioplacental stage is never omitted, and the use of the word "placenta" in compounding the term is meant to imply merely that the membrane is concerned in metabolic exchange between the surrounding environment and the embryo. Such use may not be considered happy, since the term is obviously capable of application to the sauropsidan egg, in connection with which the word "placenta" seems out of place. But it falls into line with the accepted terms which follow, and is an expression of what we believe to be a real homology, namely that of the sauropsidan chorionic ectoderm with the mammalian trophoblast.

(ii) An *omphaloplacenta*, which both ontogenetically and phylogenetically precedes the third stage, but which may be omitted in ontogeny.

(iii) An *allantoplacenta*, the final stage phylogenetically, which may never be attained (some marsupials), and which may follow directly upon the chorioplacental condition (most Eutheria), the omphaloplacenta having been eliminated.

Since it is our intention upon a future occasion to expand the thesis briefly outlined in this section, we have not burdened our list of references with the voluminous literature of placentation. References to the workers whom we mention will be found in the bibliographies to Hill's papers, which we include.

vii. *Summary and Conclusions.*

The present communication consists of a description of the placentation, at one stage of the Scincid lizard *Lygosoma* (*Liolepisma*) *entrecasteauxi*, with what we consider to be adequate figures. We hope to obtain earlier ontogenetic stages during the coming summer which will render possible a more extended account. The chief facts observed and conclusions arrived at are as follows:—

1. The lizard is strictly viviparous and not ovo-viviparous, no trace of shell or albumen having been observed.

2. An *omphaloplacenta* is present, which is in a state of regression, but shows some evidence of having been more actively functional at an earlier stage.

3. A true *allantoplacenta* is present, comprising a uterine part of vascular villous ridges with modified epithelium, and a foetal part with greatly modified chorionic ectoderm and a complex allantochorion.

4. The main allantoic blood vessels passing to the placental area are carried across the cavity by means of a remarkable fold in the inner wall.

5. The occurrence of true placentation in two not very closely related Scincid lizards, *Lygosoma* and *Chalcides*, in Australia and Europe respectively, indicates that the allantoplacenta is a functional adaptation, which may have arisen independently many times in evolution, and upon the mere occurrence of which phylogenetic statements cannot justifiably be based.

6. A consideration of reptilian placentation suggests to us three stages of placentation, *chorioplacenta*, *omphaloplacenta*, and *allantoplacenta* arising in that serial order both in ontogeny and in phylogeny.

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EXPLANATION OF PLATES XLVII-XLIX.

Lettering.

All. allantois; *All. Ch.* allantochorion; *All. St.* allantoic stalk; *Amn.* amnion; *Amn. C.* amniotic cavity; *Cap.* capillary; *C.b.v.* chorionic blood-vessel; *C.E.* chorionic ectoderm; *C.T.* connective tissue; *Ch.* chorion; *Co.* coagulum; *Foet. Plac.* foetal placenta; *I.A.W.* inner allantoic wall; *Mus.* muscle; *Plac.* placenta; *Pl.* pleated fold of inner allantoic wall; *S.A.C.* sero-amniotic connection; *U.A.* (1 & 2) umbilical arteries; *U. St.* umbilical stalk; *U.T.* uterus; *U.V.* umbilical vein; *Ut. W.* uterine wall; *Ut. b. v.* main uterine blood-vessels; *Ut. Cap.* uterine capillaries; *Ut. plac.* uterine placenta; *Ut. V.* uterine villous ridge; *Vac.* vacuole; *V.A.* (1 & 2) vitelline arteries; *V.V.* vitelline vein; *Y.G.* yolk-granules; *Y.S.* yolk-sac; *Y.S. Plac.* yolk-sac placenta; *Y. St.* yolk-stalk.

Plate xlvii.

Fig. 1.—Left uterus of *L. entrecasteauxi* from dorsal aspect with three embryos, showing placental areas.

Fig. 2.—Foetus of same with uterine wall and foetal membranes partially dissected away to show general relations.

Fig. 3.—Stereogram to show relations of allantois and yolk-sac, with their respective stalks and placental regions.

Plate xlviii.

Fig. 1.—Photomicrograph of total preparation of uterine placental area, showing villous ridges and uterine blood-vessels.

Fig. 2.—Photomicrograph of section of the allantoplacental region showing general relations of foetal and maternal membranes.

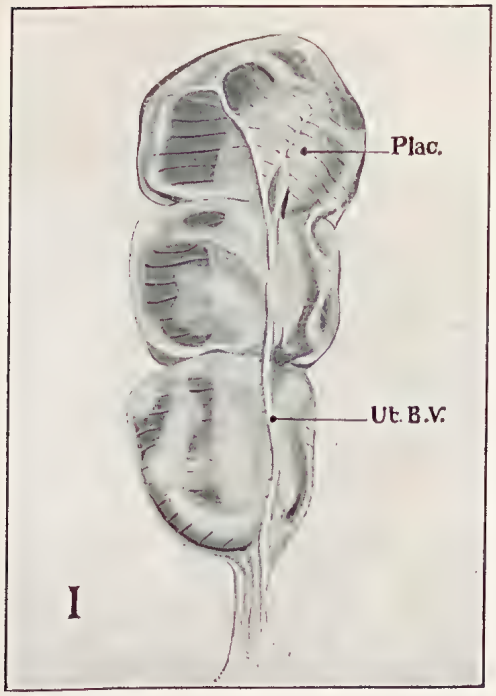
Fig. 3.—Photomicrograph of section of uterine wall showing villous ridges and their capillary vessels.

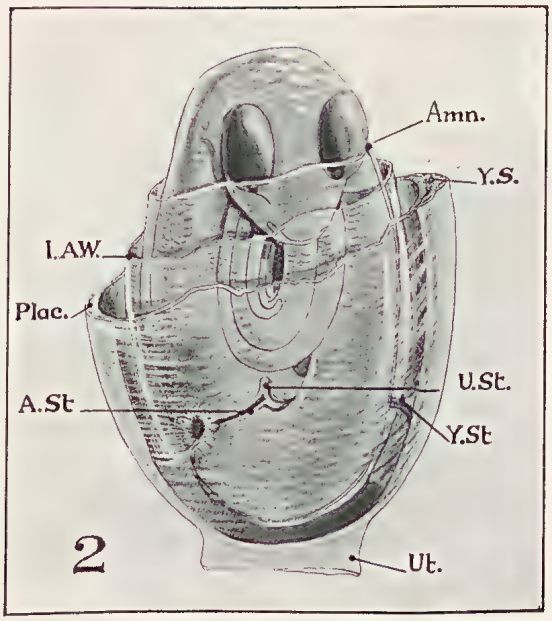
Fig. 4.—Photomicrograph of section of portion of embryo showing reduced yolk-sac passing round head region, with coagulum lying between serosa and uterine wall.

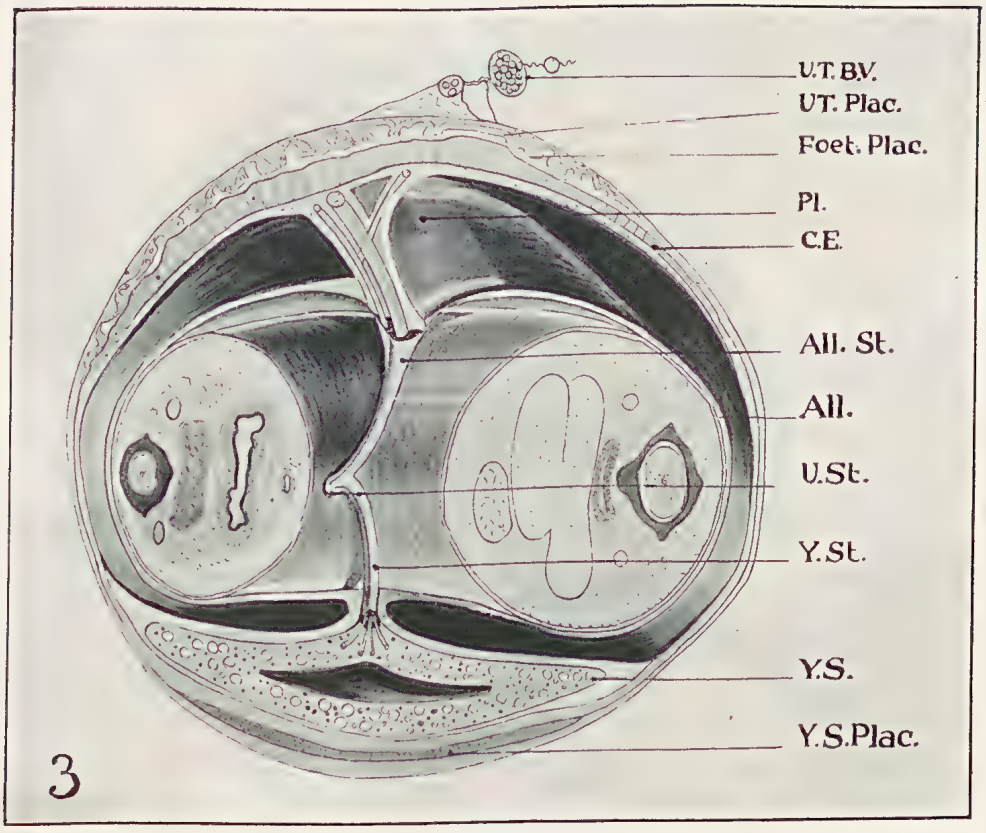
Fig. 5.—Photomicrograph showing yolk-sac at a somewhat earlier stage, with contained coagulum.

Plate xlix.

Fig. 1.—Section of portion of foetal allantoplacenta showing transition of chorionic ectoderm from placental to extra-placental condition.
Fig. 2.—Section of allantoplacental region showing apposition of chorionic ectoderm to maternal villous ridges.
Fig. 3.—Section of omphaloplacental region showing details of foetal membranes and uterine wall.
Fig. 4.—Section of portion of yolk-sac wall.
Fig. 5.—Section of margin of allantoplacental region showing method of transference of allantoic blood-vessels across cavity.
Fig. 6.—Section of umbilical stalk.
Fig. 7.—Section through 4 mm. embryo of *Tiliqua scincoides* to show early thickening of chorionic ectoderm over embryonic area.







H. Weekes del. Placentation in *Lygosoma entrecasteauxi.*

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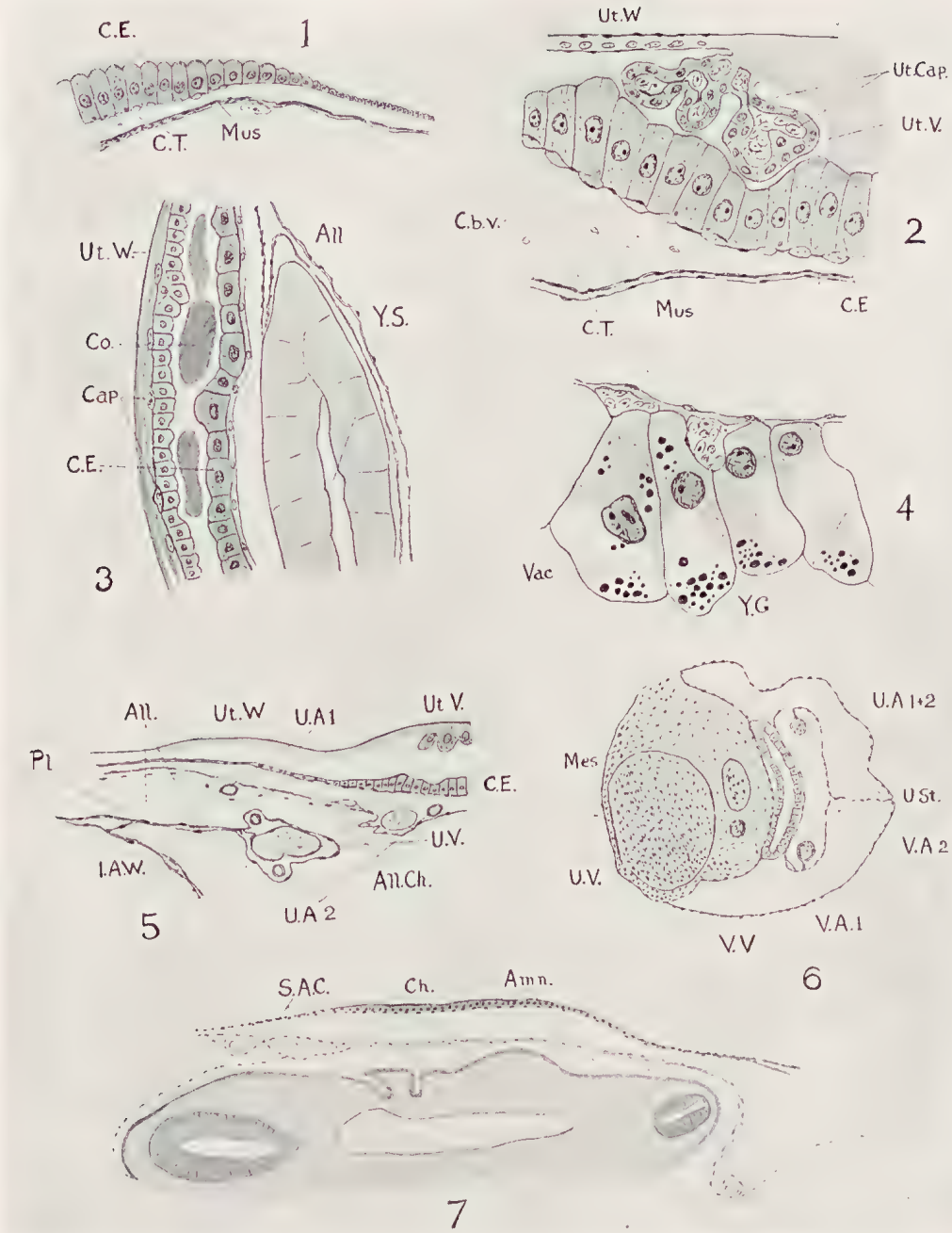
VICTORIA

Placentation in *Lygosoma entrecasteauxi.*

VICTORIA



L. H. & H.C.W. del. Placentation in *Lygosoma entrecasteauxi.*

DESCRIPTION OF A NEW SPECIES OF MYCETOPHILIDAE (DIPTERA) WITH LUMINOUS LARVAE.

By E. W. Ferguson, M.B., Ch.M.

(One Text-figure.)

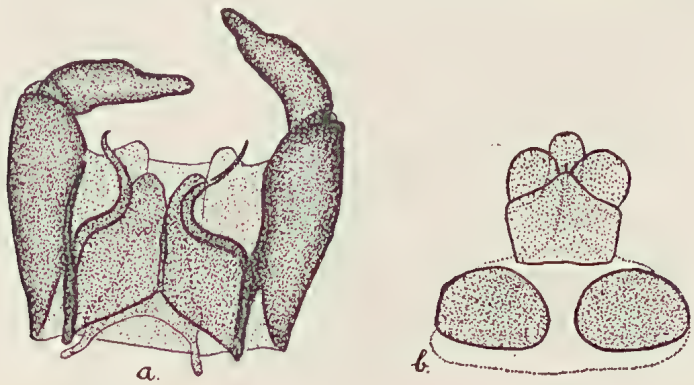
[Read 25th November, 1925.]

The occurrence of a species of Mycetophilid with luminous larvae in Tasmania does not appear to have been recorded hitherto.

The species concerned, of which a pair in copula and a single male were taken by Mr. A. M. Lea in the Ida Bay Caves, appears to belong to the same genus as that occurring in New Zealand. This latter species was described by Skuse (Proc. Linn. Soc. N.S.W., (2) v, 1890, 678) under the name of *Bolitophila luminosa*. A new genus—*Arachnocampa*—was recently erected by Edwards (*Ann. Mag. Nat. Hist.*, (9) xiv, 1924, 175) for this species. The Ida Bay specimens conform well with Edwards's description of the genus, but the species appears distinct from *A. luminosa*.

Arachnocampa tasmaniensis, n. sp.

♂. Antennae very long, longer than head and thorax together, the two basal joints small, cup-shaped, the 15 flagellar joints long, cylindrical, the first flagellar



Arachnocampa tasmaniensis, n. sp.
a. Dorsal view of parts seen after removal of ninth tergite.
b. Ninth tergite and anal lobes.

joint 1½ times as long as the second, the others decreasing progressively in length towards the apex, the 4 subterminal approximately equal in length, the terminal joint very small; scape light brown, flagellum lighter yellowish-brown at base, becoming darker after the second joint. Palpi long, incurved, the apical joint

flagelliform, yellow. Head black, with some dark hairs on occiput and face, eyes hairy. Mesonotum dark brown with an indistinct darker dorsocentral stripe on each side, these stripes bearing a double row of short hairs; median line also slightly darkened; a tuft of dark hairs above each wing root. Prothoracic ring and lateral membraneous portion of thorax between mesonotum and pleurae testaceous in colour. Scutellum light brown. Pleurae dark brown. Abdomen elongate, cylindrical, the first and apical segments dark brown, the remaining segments dark brown with a broad basal yellow band. Coxae pale yellow or whitish, the anterior practically entirely so, the intermediate and hind coxae dark brown at apex; femora light yellowish-brown, the posterior pair darker, tibiae and tarsi dark brown; anterior metatarsi 1½ times as long as tibiae; intermediate tibiae and metatarsi subequal; posterior tibiae not quite 1½ times as long as metatarsi.

Wings elongate, not as long as abdomen, brownish in colour; costa extending to apex; R_1 ending in costa, anterior to apex and about opposite distal end of M_3; Rs arising anterior to end of subcostal, curved towards apex, ending in costa at extreme apex; subcostal ending in costa near middle and slightly before distal end of Cu. Halteres yellowish; clubs infuscated.

♀. Similar, thoracic lines and abdominal annulations less distinct; apical lamellae light brown.

Length 11 mm.; wings 7 mm.; antennae 4½ mm.

Type and allotype female in South Australian Museum; paratopotype male in collection of Dept. of Public Health, Sydney. The specimens bear the following label:—

> "Ida Bay Caves, Tasmania. Arthur M. Lea, December, 1909. In total darkness fully ¼ mile from entrance."

The species differs from the description of *A. luminosa* Skuse to some extent in the coloration, but chiefly in the relative lengths of the fore metatarsi and tibiae.

Concerning the larvae of this species, Mr. A. M. Lea writes as follows:—"The Ida Bay glow-worm was in the caves in thousands; you saw them sparkling in crowds. They are eaten by a spider-like creature and by the *Idacarabus* I named. The larvae construct a hanging affair for themselves, along which they pass; the glow is very bright, the area being about the size of the head of a London hill pin. I saw an apparently identical larva under logs in deep gullies and I am told they are often to be seen in abandoned mines."

It would appear from this description that the habits of the cave larvae are very similar to those of the Waitomo Caves in New Zealand. The identity of the luminous larvae found in gullies and old mines is more doubtful, and it will probably be found that these belong to some species of *Ceroplatus*.

I am indebted to Dr. I. M. Mackerras for the figures of the male genitalia which were drawn from the paratype; the hairs on the segments are not shown.

THE NEMESTRINIDAE (DIPTERA) OF THE AUSTRALASIAN REGION.

By I. M. Mackerras, B.Sc., M.B., Ch.M., Linnean Macleay Fellow of the Society in Zoology.

(From the Department of Zoology, University of Sydney.)

(Plate 1 and seventeen Text-figures.)

[Read 25th November, 1925.]

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Introduction.

The essential basis of zoogeographical studies is an accurate knowledge of the affinities of animal groups from different regions. A careful study of the available literature shows that in the Nemestrinidae, as in many other Diptera, the information as to generic relationships, while highly suggestive, is not conclusive. The first object of this work, then, is to place in the hands of workers who have the material from other regions, especially the Neotropical, a study of the Australasian members of this family sufficiently detailed for accurate comparative work. At the same time, a careful systematic review has been made and all available information about the Australasian species has been given in order to enable Australian dipterists to recognize the known species and to pave the way for further systematic work and the study of various local problems.

The first study of Australian material was made by Westwood (1835), who erected the subgenus *Trichophthalma* for the reception of three species, two undoubtedly, and probably all, Australian. He was followed by several workers, notably Macquart and Walker, who described a number of Australian species, placing them in various genera. The latter appears to have been the first to raise *Trichophthalma* to full generic rank. The first work of a revisional character was undertaken by Wandolleck (1897), who dealt with the genera *Trichopsidea* and *Atriadops* in considerable detail. Later, Lichtwardt (1909, 1910*a*, 1912) dealt with the Australian species as fully as material permitted in the course of his review of the Nemestrinids of the world. In this country White (1914, 1916) and Hardy (1924) are the only workers who have dealt with the family. The latter reviewed the taxonomy of the Australian species, described new antennal characters and gave brief notes on many of the species. His work and also that of Lichtwardt have been of the greatest assistance in the systematic side of the present study.

Six genera have been described for Australasia and 40 specific names used. Of these I consider 22 as definitely valid and 2 I cannot place, one of which is the genotype, *T. bivittata* Westw. All the valid species of which I have material are redescribed in detail and the original descriptions are also given, so that other workers may be able to check my conclusions without difficulty. These detailed descriptions are especially necessary in the genus *Trichophthalma*, the species of which are often to be separated with certainty only by a careful comparison of all the characters. Fifteen (15) species, 3 subspecies and 1 variety of this genus are here described as new, the number of species in each genus being as follows for this region: *Trichophthalma* 30, *Exeretoneura* 2, *Trichopsidea* 1, *Atriadops* 1, *Nycterimyia* 2, *Nycterimorpha* 1, the total being 37 species for the family, a number which will undoubtedly be increased considerably as more extensive collections are made, especially in Western Australia and South Australia and in North Queensland and the adjacent islands. Since the above was written, I have received a note from Mr. Hardy stating that he has discovered a new and very interesting genus, which is described below.

Of the six genera, four are endemic, *Atriadops* and *Nycterimyia* being also represented in other regions. *Trichopsidea* and *Nycterimorpha* are closely related to these two and form with them a group which has obviously reached Australia from the Oriental Region and which is, equally obviously, the most specialized of the Australian Nemestrinidae. These flies are rare, the number, both of species and of individuals, being very small. All occur on the mainland and the first three are also known from New Guinea, *Trichopsidea* also extending as far south as Tasmania. No Nemestrinid is yet known from New Zealand.

The genus *Trichophthalma* stands in marked contrast with those just described. While showing many archaic characters, it is yet the dominant and successful genus in this region, being found commonly in every part of Australia and in every climatic environment where suitable food plants occur, with the possible exception of North Queensland where members of this genus appear on present knowledge to be rather rare. It is not known from the drier parts, possibly owing to the absence of suitable flowering shrubs, or possibly because of a direct effect of aridity. It is abundant on the mainland of Australia and extends to Banks Is. in the north and to Tasmania in the south. No specimens are yet known from New Guinea. Its closest affinities appear to be with the Chilian genus *Eurygastromyia* Lichtwardt.

Such cases of animals which are archaic and are found in a peripheral region, but which are nevertheless highly successful, are difficult to explain by the central thrust idea which underlies Matthew's (1915) theory of radial dispersal, at any rate as applied to the Diptera Brachycera. The facts are that the Trichophthalmas form part of an important and conspicuous dipterous fauna which has its nearest allies in South America and which dominates a particular environment in eastern Australia, namely the southern and the mountain areas. It must be remembered also that Wallace's Line has proved no barrier to the invasion of more recent highly specialized and successful species from the Oriental Region, and that the "Antarctic" element has been able, not only to survive and flourish in a particular part of the country, but sometimes, as with the Trichophthalmas, to invade successfully those areas which are most suitable for the development of the Oriental element. Many of these Antarctic types are primitive, but they cannot be considered in any sense unsuccessful. Primitiveness and non-success do appear to go hand in hand in the mammals, but it is a

great mistake to apply the same conclusions to the insects. Primitive characters are only retained in the Diptera Brachycera because they are of more use for a particular purpose than more specialized ones. No one could doubt that the primitive venation of the Trichophthalmas, by a slight rearrangement in the directions of veins, is made much more suitable for the particular type of flight of these insects than could be possible in any more specialized and reduced venational type, and it is a fact that, of all Australian Diptera that indulge in the hovering type of flight, the Trichophthalmas are the most efficient. It is a most beautiful case of the utilization of primitive structures by a very slight modification for a highly specialized type of activity, and is of value to the student of phylogeny, but useless to explain distribution. Besides forming a prominent element of the Australian dipterous fauna, and besides competing successfully with the more specialized Oriental element, not only in their own but in other families, the Trichophthalmas have adapted themselves to a number of different environments, some of which certainly have analogues in other regions; and it is difficult to conceive that they would not have survived had they ever occurred elsewhere than in the Australasian and the Neotropical Regions, since it is strongly indicated that they are also represented in the latter by the Chilian genus *Eurygastromyia*.

The only hypothesis which would fit in with the theory of Matthew is to assume that the ancestors of the Trichophthalmas were unsuccessful and were driven into the remote parts of the earth where they met with stimulating conditions, and there is no doubt that southern Australia was just as stimulating in the past as was the Palaearctic Region, and developed into the successful genus we now know, the same happening to their relatives of the same zone of migration which reached South America. This is a pure assumption and has, to my mind, on the evidence before me, less to recommend it than the theory that South America was joined to Australia by Antarctica, and the suggestion that the primitive Nemestrinids spread all over the world (the period of such spreading would correspond very well with a time of fairly uniform climate in the last of Griffith Taylor's major climatic cycles— Taylor, 1919) and developed independently into the various groups now found, the Chilian *Eurygastromyia* and the Australian *Trichophthalma* originating in the south from a common ancestor. It is hoped to elaborate this point at a later date in a more general survey of the distribution of the Australian Diptera Brachycera.

The whole question hinges on the degree of relationship of the genera from the different regions. The available information strongly indicates a close affinity between the two genera mentioned, but it is not absolutely conclusive, although paralleled by other similar cases, nor is there sufficient information as to the affinities of these forms with genera from other regions. It is not possible to carry out such studies in Australia and all that can be done here is to attempt to supply a reasonable basis for comparative work for one region only, leaving the question of inter-regional relationships strongly suspected, though not proven. Whatever its relationships and whatever light they may throw on a possible Antarctic radiation, there is no doubt that *Trichophthalma* is an archaic yet highly successful genus, the presence of which in a peripheral region is difficult to account for on an hypothesis of central thrust by better adapted species.

The remaining genus, *Exeretoneura*, is an archaic one, the affinities of which are doubtful. Its distribution in Tasmania and in the eastern highlands of Australia indicates that its nearest relatives will probably be found in South America.

The material before me comprises 850 specimens, many of the species being represented by long series from several localities. It is only this abundance of material which has made it possible to carry our knowledge of this family further than Hardy (1924) has already taken it, and I wish to express my very grateful thanks to the following institutions and individuals for the use of material and to the latter for much assistance in the field and in other directions: The Queensland Museum, Brisbane; The Australian Museum, Sydney; The Macleay Museum, University of Sydney (which includes the valuable collection made at Barrington Tops, N.S.W., by Professor Harrison and the members of his expedition); The National Museum, Melbourne; The South Australian Museum, Adelaide; The Entomological Branch, Dept. of Agriculture, N.S.W.; Dr. T. L. Bancroft, Dr. E. W. Ferguson, Mr. G. M. Goldfinch, Mr. G. H. Hardy, Professor L. Harrison, Mrs. I. M. Mackerras, Miss L. Wood. To Mr. A. J. Nicholson my gratitude is also due for permission to publish his excellent photographs of the living insects which appear in Plate I, and to Mr. A. Musgrave for Text-fig. 1. I am also much indebted to Professor T. Griffith Taylor for advice on questions of geography and climatology.

Key to Australasian Genera.

1. Proboscis prominent, at least as long as head, R_{4+5} forked .. *Trichophthalma* Westw.
   Proboscis inconspicuous and much shorter than head, or vestigial 2
2. R_{4+5} forked, proboscis Leptid-like ..... *Exeretoneura* Macq.
   R_{4+5} not forked, proboscis vestigial 3
3. M_1 and M_2 at least partly separated distal to oblique vein 4
   M_1 and M_2 completely fused distal to oblique vein 5
4. M_1 and M_2 fuse before reaching wing margin, wings clear, ocelli present.....
   ..... *Trichopsidea* Westw.
   M_1 and M_2 separate to wing margin, wings brown, ocelli absent .... *Atriadops* Wand.
   M_1 and M_2 separate to wing margin, wings clear and hind angle absent, ocelli present ..... *Cyclopsidea*, n. gen.
5. Hind angle of wing well developed, venation not unusual ..... *Nycterimyia* Licht.
   Hind angle of wing absent, venation and shape of wing very peculiar.....
   ..... *Nycterimorpha* Licht.

Genus Trichophthalma Westwood.

Nemestrina subg. *Trichophthalma* Westwood, 1835, p. 448.—*Hirmoneura* Meig., in part; Macquart, 1840, 1846, 1850; Jaennicke, 1867.—*Rhynchocephalus* Fisch., in part; Newman, 1841.—*Trichophthalma* Westw.; Walker, 1849, 1857; Bigot, 1881; Lichtwardt, 1910*a*, p. 371; White, 1914, p. 65; Hardy, 1924, p. 449, figs. 1, 6, 7.

Definition.

Eyes large, contiguous or narrowly separated in the male, slightly more separated in the female; covered with dense long hairs; ocelli present. Proboscis elongate; palpi small but well developed. Antennae with basal segments small, cylindrical; third segment larger, conical or sub-cyclindrical; style long, three-segmented. Wings with R_{4+5} forked, no inter-radial *c-v*, M_{1+2} only just meeting R_{4+5}, M_1 and M_2 separate, M_4 fused with M_3 to form tip of oblique vein, C continuous all round wing margin. Genitalia with well developed basistyles and separated median part of ninth sternite, distostyles and basi-distostyles also prominent; aedeagus not fused with other parts to a marked extent; anal lobes small, membranous. Lamellae of ovipositor not greatly elongate.

Genotype, *Trichopthalma bivittata* Westwood, 1835.

Hardy (1924, p. 450) named *costalis* Westw. as the genotype, overlooking the fact that Lichtwardt (1910*a*, p. 371 and 1910*b*, p. 601) designated the first described species, namely *bivittata* Westw. as the genotype. Lichtwardt's designa-

tion is unfortunate as this species cannot be placed at present; still it is quite unequivocal and so must stand. It is possible that the type is in the British Museum and that it will prove on examination to be a species which is at present well known under another name.

Text-figure 1.—*Trichophthalma rosea* Macq. ♀ × 2. (Photo.—A. Musgrave).

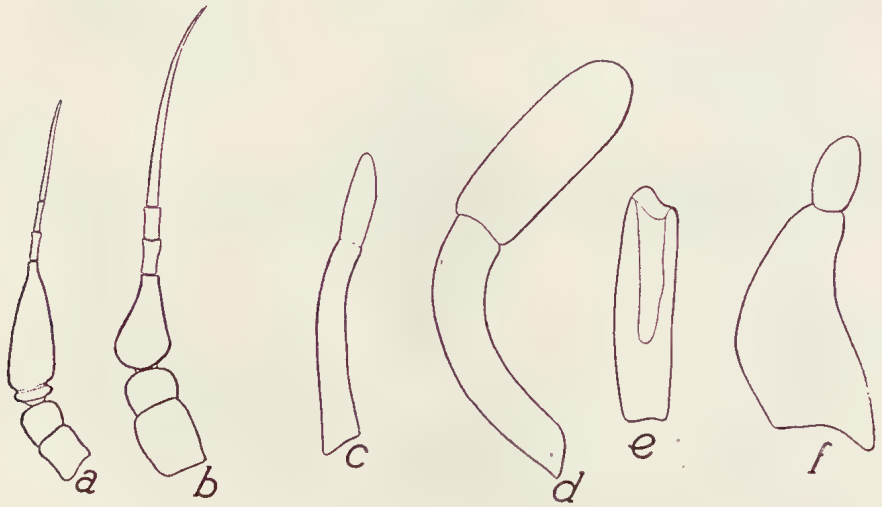
Morphology.

For reasons detailed above it is proposed to deal here in considerable detail with those characters of taxonomic and general morphological importance. In general, these are very active flies, of large to fairly small size and of stout to moderate habit. They bear a rather close superficial resemblance to certain Tabanids, especially those of the genus *Pelecorhynchus*. The general appearance of one type is well shown in Text-fig. 1 and in Pl. 1. On the available information this genus is only to be separated from *Eurygastromyia* Licht. by the different shape of the head and by the longer proboscis and much broader abdomen of the latter. It has been possible to divide the genus into groups, subgroups and series on characters that are readily accessible. This arrangement has been followed, rather than the simpler one of merely making a number of groups, in order to stress the degree of relationship of the various species. This grouping not only simplifies the discrimination of species, but rationalizes our studies of problems of local distribution. While the group characters used are of greater value than those separating many "genera" of Tabanidae, the genus forms such a natural homogeneous whole that it is not thought advisable to propose even subgeneric separation.

Antennae.

Hardy (1924, p. 451) has pointed out that the genus may be divided into two groups on characters provided by the third segment of the antenna. In the first

group (Text-fig. 2*b*) this segment is short and conical and is not divided into two parts by a sulcus near its base; the majority of the species belong here and I have called it the *costalis* group. In the second group (Text-fig. 2*a*) it is elongate, more parallel sided and is distinctly divided by a groove near its base; this forms the *rosea* group. This grouping is eminently natural and forms the primary subdivision of the genus, being supported by differences in body form and in several important structural characters.



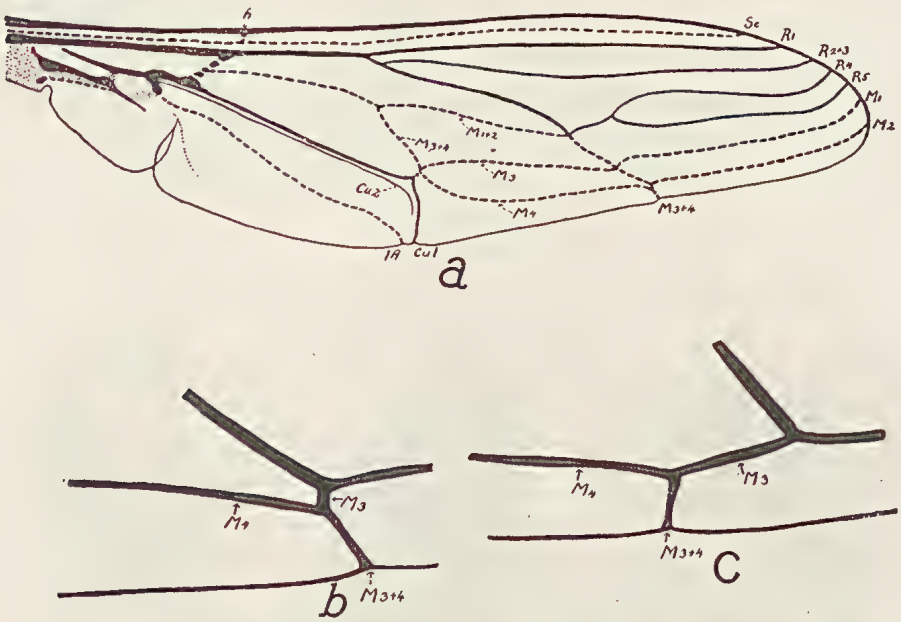
Text-figure 2.—*a*, Antenna of *T. rosea* Macq.; *b*, Antenna of *T. novae-hollandiae* Macq.; *c*, Palp of *T. costalis* Westw.; *d*, Palp of *T. novae-hollandiae* Macq.; *e*, Distal segment of same showing apical pit; *f*, Palp of *T. rosea* Macq. *a*, *b* and *e* are from cleared preparations. *a* and *b* are much less magnified than *c*, *d*, *e* and *f*.

Mouth parts.

The proboscis is as long as, or usually longer than, the head, and its length and stoutness, together with the size of the labellae, are often of use in the separation of species. It must be remembered, however, that the proboscis is more or less extensible, so there may be quite marked differences between specimens of the same species. Differences in stoutness, and especially in the size of the labellae, are much more reliable, unless the difference in length is very marked. The mouth parts in both sexes have a strong resemblance to those of the male Tabanid, the mandibles being absent or represented by a short spike which is inconstant in its occurrence, while the maxillae, hypopharynx and epipharynx are elongate and stylet-like. The labium and labellae are also precisely similar to the Tabanid.

The palpi afford a ready means of dividing the *costalis* group into two subgroups. In the *costalis* subgroup the basal segment is long and slender and the apical, which is only indistinctly separated, is short and tapers to a rounded apex in which there is a deep pit, the mouth of which may be difficult to see; the palp is never very densely haired, nor so buried in the facial hairs as not to be clearly visible. The species related to *T. punctata* Macq. have a definitely slenderer, more pointed palp than is seen in *T. costalis* Westw. and its immediate allies. In the *novae-hollandiae* subgroup (Text-fig. 2*d* and 2*e*) the palp is large

and obvious, the apical segment is clearly marked off and is as large as, or larger than, the basal, while the apical pit is extensive and has a widely open mouth. I have never seen anything in these subgroups in the way of linking forms. In the *rosea* group there is considerable variation. The second segment is always short and fairly clearly marked off from the basal. In all species except *T. laetilinea* Walk. and *T. ricardoae* Licht. the palps are greatly obscured by facial hair and are themselves covered with long hair. *T. rosea* Macq. and *T. eques* Schin. are alone in the genus in having no apical pit. The palpi of *T. laetilinea* Walk. and *T. ricardoae* resemble somewhat those found in the *costalis* subgroup.

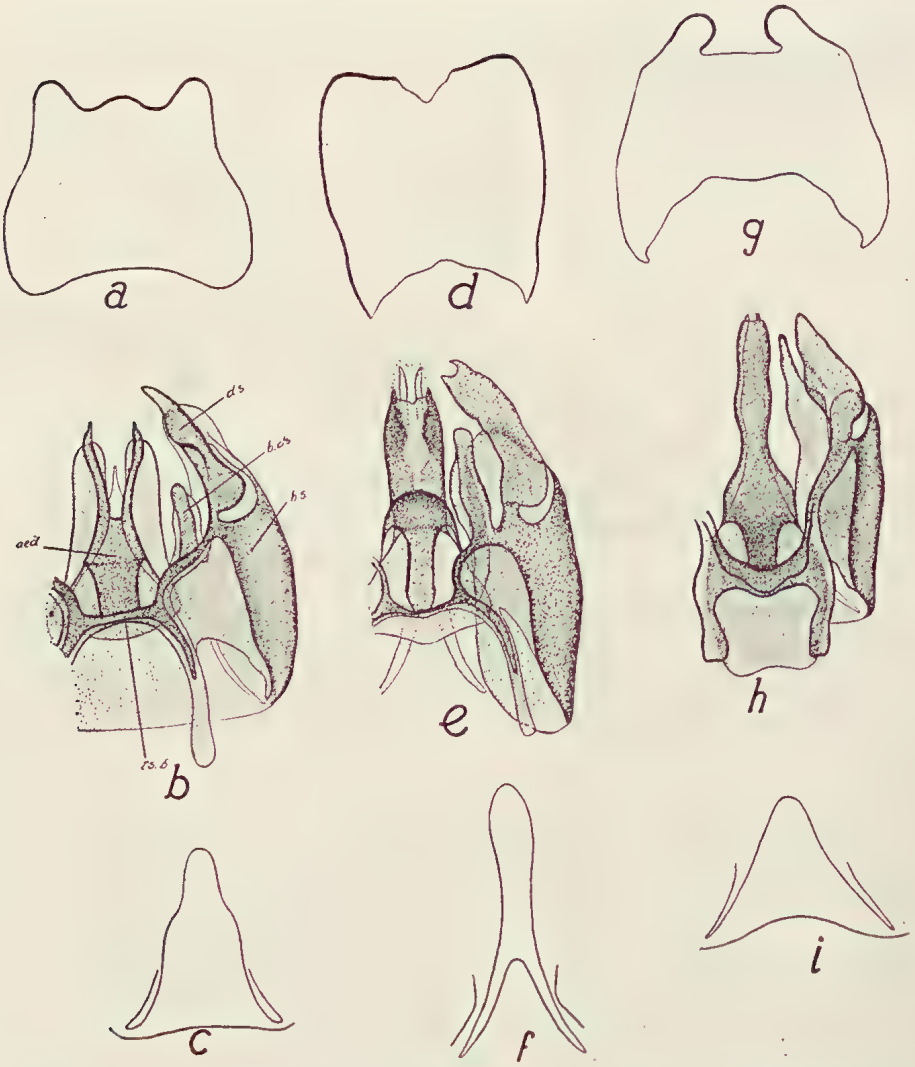


Text-figure 3.—*a.* Wing of *T. bancrofti*, nov.; here, and in all other figures of the wings, R and its branches, Cu_1 and Cu_2 are solid, Sc, M, and 1A are broken, *c-v* is dotted. *b.* M_{3+4} and adjacent veins in *T. bancrofti*, nov. *c.* Same in *T. rosea* Macq.

Venation.

In Text-fig. 3*a* the wing veins have been identified in accordance with Tillyard's (1919) modification of the Comstock-Needham system. The distinction between convex and concave veins is of the greatest use in the Diptera, and especially in this family where venational homologies are a little difficult to make out. It is a pity that this, or the parent system, is not in more general use among dipterists, simply because it is the most accurate and convenient, if for no other reason. It is sometimes difficult to know exactly what is meant in referring to a vein under the older names unless it is indicated on a figure. The important land-marks in this genus are the strong convexity of that part of the oblique vein made up from Rs and R_{4+5}, and the strongly convex Cu_1. Though Sc is made to appear joined to R_1 in many illustrations, it is really free right to the base of the wing and lies for the greater part of its length in a deep concavity almost vertically beneath R and R_1 in all genera known

to me. The oblique vein has the composition: Rs, R_{4+5}, *r-m*, M_{1+2}, M_{2+3}, M_3, M_{3+4}. R_{4+5} in general just touches M_{1+2}, but in a few cases *r-m* is not quite eliminated and may just be detected; a similar statement applies to *m-cu*, though this crossvein is more usually recognizable. A useful character is found in the tip of the oblique vein, which is made up of M_{3+4}. In the *costalis* group it is almost continuous with the rest of the oblique vein; in the *rosea* group, on the other hand, it is displaced back, usually to a considerable extent, towards the root of the wing (compare Text-fig. 3*b* with Text-fig. 3*c*). As in the case of the palpi, *T laetilinea* Walk. and *T. ricardoae* Licht. show an intermediate condition, nevertheless the displacement is more marked than in any of the *costalis* group.



Text-figure 4.—Genitalia in the genus *Trichophthalma*; top, ninth tergite, middle, dorsal view of parts seen after removal of ninth tergite, bottom, ninth sternite; the ninth tergite is drawn at a smaller magnification than the rest. *a*, *b*, *c*, *T. costalis* Westw., *d*, *e*, *f*, *T. nigrovittata*, nov., *g*, *h*, *i*, *T. rosea* Macq. Lettering of parts in text.

Certain venational aberrations have been met with in some species and these are worth recording here. Macquart mentions, when describing *H. nigriventris* (= *T. punctata* Macq.), the presence of an accessory vein crossing cell R_3 on one side only in one of his specimens which he illustrates (Macquart, 1850, p. 98, Pl. 9, fig. 9). I have not seen this vein, but an accessory crossvein crossing cell M_1 is frequent on one or both sides in *T. primitiva* Walk.; in some cases two crossveins are present in this situation. This vein is also present in one specimen of *T. rosea* Macq. and in one of *T. confusa*, nov., on one side only in each. Usually it is situated near the middle of the cell, but in the specimen of *T. confusa*, nov., it is close to the base. In one specimen of *T. nigrovittata*, nov., there is a short stump leaving M_1 and ending in the field of the wing between M_1 and M_2. Cell M_1 is sometimes closed completely at its apex or markedly narrowed in *T. rosea* Macq. Finally, in the unique female of *T. grisea*, nov., which has only one wing intact, M_{3+4} is completely absent, M_4 and M_3 forming a continuous unbroken line a little distance from the margin of the wing, a condition resembling that found in the Palaearctic *Rhynchocephalus tauscheri* Fisch. Accessory veins near the posterior margin of the wing also occur in *Atriadops javana* Wied.

Male genitalia.

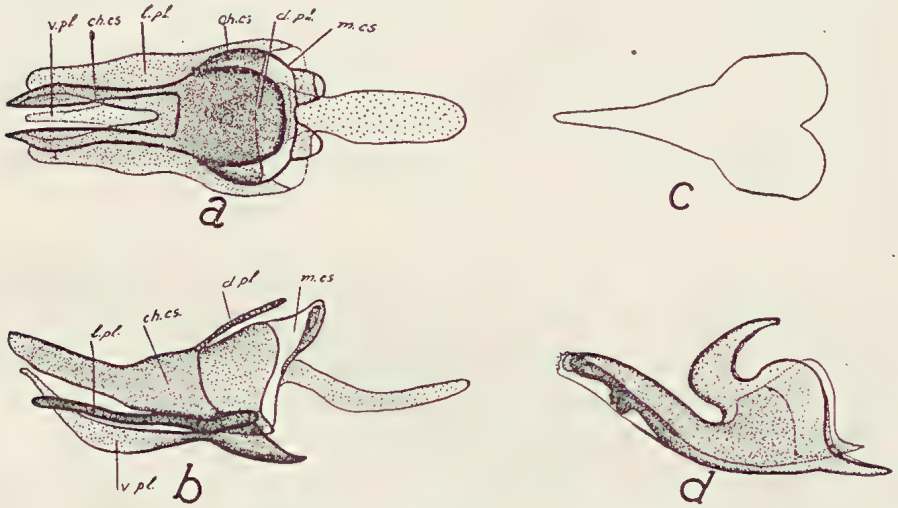
A study of these parts has been of the greatest assistance in confirming the division of the genus into groups and subgroups on other characters and, in certain cases, in the separation of closely related species. With the information now available, it is not often necessary to dissect these parts, as we know the constancy of the other characters, and the shape of the ninth tergite, which can almost always be seen without dissection, is usually sufficient for taxonomic purposes. Nevertheless, any doubtful species should be dissected and examined in detail. The apparatus comprises the ninth tergite and sternite with its appendages, together with the parts lying between them, namely the tenth segment and anus dorsally and the aedeagus enclosing the transmitting organs ventrally.

The *ninth tergite* (Text-fig. 4, *a*, *d*, *g*) is heavily chitinized, more or less quadrilateral in shape, covered dorsally with long hairs, and lies arched over the other parts which it covers in completely. The shape of its distal end is, with few exceptions, characteristic for each group, and also differs in detail in the members of the *punctata* series.

The *ninth sternite* (Text-fig. 4, *c*, *f*, *i*) is nearly completely separated off from the basistyles and is developed posteriorly into a finger-like process, which is covered ventrally with soft hair. Its shape and extent differs in the three major divisions, being smallest in the *rosea* group, longest and most slender in the *novae-hollandiae* subgroup and intermediate in the *costalis* subgroup. It is constant in each and does not appear to show specific differences of value within a group or subgroup. This well developed type of sternite, which is separated off from the basistyles, is markedly different from the condition usually met with in the Tabanoidea, the sternite generally forming a strong bar from which the basistyles arise by a broad zone of attachment.

The *basistyles* or claspers (Text-fig. 4, *b*, *b.s.*) are very well developed. Each is deeply notched proximally, the medial side of the notch being produced into the body as a strong strut for the attachment of muscles. A transverse bar, the morphological posterior end of the ninth sternite (Text-fig. 4, *b*, *ts.b.*), joins the two basistyles together dorsally and gives attachment to the aedeagus. The

distal end is produced much further ventrally than dorsally. The *distostyle* (Text-fig. 4, *b*, *d.s.*) is attached to the basistyle dorsally and overlies its ventral projecting part; its shape is often of use in the separation of species. Lying between the basistyle and the aedeagus is a process composed of a dorsal and ventral lamina, both of which are attached proximally to the medial aspect of the basistyle (Text-fig. 4, *b*, *b.ds.*). Its homologies are somewhat doubtful, but I am calling it the *basi-distostyle*, although it is quite possibly not the homologue of the structure so named in the Nematocera. The size of this structure is constant for each division and the differences can be best appreciated from a study of the figures.



Text-figure 5.—*a*, dorsal, *b*, lateral, view of aedeagus of *T. rufonigra*, nov.; *c*, ventral plate of same; *d*, lateral view of aedeagus of *T. nigrovittata*, nov. *v.pl.* ventral plate, *ch.cs.* chitinized part of copulatory sac, *l.pl.* lateral plate, *d.pl.* dorsal plate, *m.cs.* membranous part of copulatory sac.

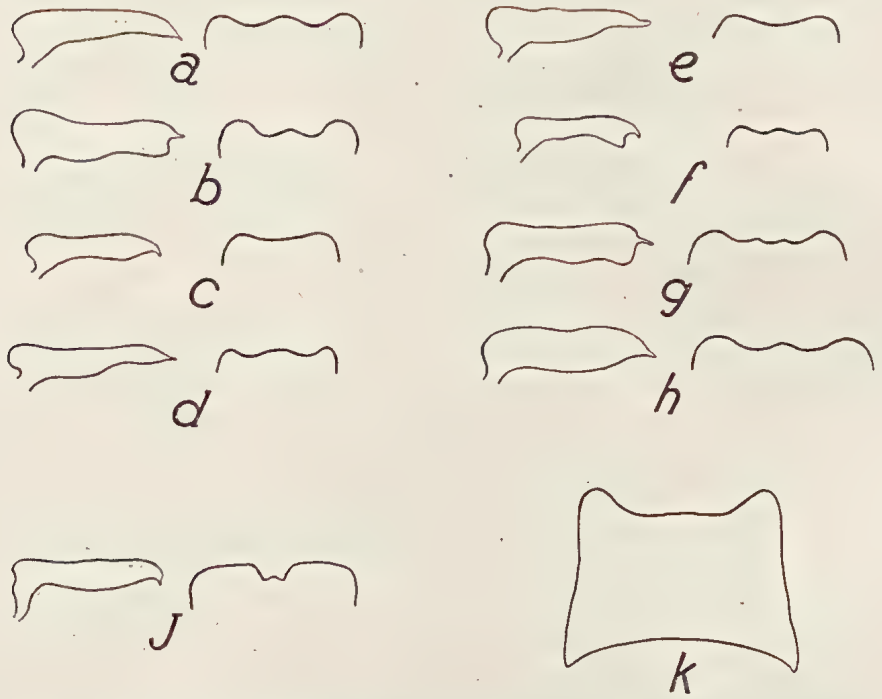
The *aedeagus* in the *costalis* subgroup (Text-fig. 4, *b*, *aed.*) is composed of dorsal, lateral and ventral plates and the chitinized part of the copulatory sac, which is deeply incised distally. The dorsal plate is attached proximally to the transverse strut joining the two basistyles, while distally it becomes fused with the chitinized part of the copulatory sac; this is the only chitinous attachment in this genus of the aedeagus to the other parts of the genitalia. The relations of these parts are shown in Text-fig. 5, *a* and *b*. The proximal part of the copulatory sac is membranous with two small patches of chitin for muscle attachment. The transfer apparatus (seen dimly beneath the dorsal plate in Text-fig. 5, *a*) is cone-shaped and is produced proximally into a stout strut for the attachment of muscles. In the *novae-hollandiae* subgroup the chitinized parts are fused in such a way that their individual identity is difficult to make out, and the lateroventral aspect, which consists of the down-turned lateral edges of the lateral plates, usually bears teeth. The dorsal element is produced into a prominent bulb overhanging the tubular distal part (Text-fig. 5, *d*). In the *rosea* group the fusion is complete, the distal part forming a simple tube; there are some specific differences in the aedeagus of this group (see Text-fig. 9).

The tenth segment is fairly well developed and the anal lobes are membranous and short, differing markedly from the condition found in *Trichopsidea* and *Atriadops*.

The outstanding characters of each type of genitalia may be summarized as follows:

costalis subgroup (Text-fig. 4, *a*, *b*, *c*): Genitalia broader than long. Distal end of ninth tergite sinuous (except *T. fusca*, nov., which resembles the *novae-hollandiae* subgroup). Ninth sternite broad and produced into a short median lobe. Distostyle of variable shape, but never resembling those found in the other divisions. Basi-distostyle short, never as long as the ventral part of the basistyle. Aedeagus made up of separated bars of chitin, proximal part never forming a bulb overhanging the distal slenderer part.

novae-hollandiae subgroup (Text-fig. 4, *d*,*e*,*f*): Genitalia longer than broad. Distal end of ninth tergite with a triangular notch (except *T. nigripes* Macq.).



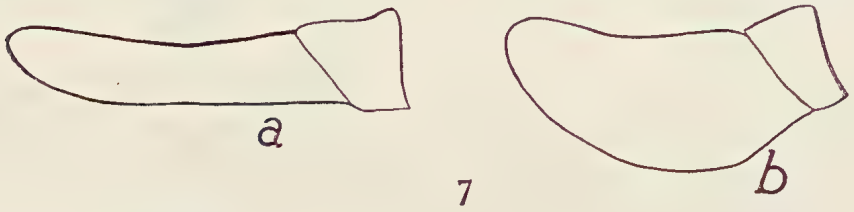
Text-figure 6.—Distostyle (left) and distal end of ninth tergite (right) of—*a*, *T. punctata punctata* Macq.; *b*, *T. punctata orientalis*, nov.; *c*, *T. fulva* Walk.; *d*, *T. confusa*, nov.; *e*, *T. bivitta nigricosta*, nov.; *f*, *T. harrisoni*, nov.; *g*, *T. nicholsoni*, nov.; *h*, *T. leucophaea* Walk.; *j*, *T. fusca*, nov.; *k*, ninth tergite of *T. nigripes* Macq.

Ninth sternite long and slender, distostyle with a deep notch in its distal end. Basi-distostyle of medium size, just reaching as far as ventral part of basistyle. Parts of aedeagus fused to form a tube, incomplete ventrally; proximal wider part forming a bulb overhanging the distal part. Ventral aspect bearing stout teeth on each side (except *T. nigripes* Macq.). This species differs markedly

from the rest of the subgroup in the shape of the ninth tergite and in the absence of teeth on the aedeagus, but agrees in all other characters and does not warrant separation into a distinct subgroup.

rosea group (Text-fig. 4, *g*, *h*, *i*): Genitalia longer than broad. Distal end of ninth tergite with a deep notch with overhanging sides. Ninth sternite very small, hardly projecting beyond the point of closest approximation of the basistyles to each other. Distostyle bulky, of characteristic shape. Basi-distostyle very large, projecting as far as the apex of the distostyle or nearly so. Aedeagus completely fused to form a slender tube, basal part forming a bulb overhanging the distal part in most species, not in all; no teeth on ventral aspect.

In regard to the separation of species within a group, one may state that in the case of one or two species, notably *T. fusca*, nov. and *T. nigripes* Macq., the genitalia are absolutely characteristic, but the majority do not show striking specific differences. In the *punctata* series of the *costalis* subgroup, there are small differences in the shape of the distal end of the ninth tergite and of the distostyle, which, rather than clearing up the question of the species of this series, have made it considerably more complicated, but much more interesting.



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Text-figure 7.—Lamellae of ovipositor seen from the side of—*a*, *T. bancrofti*, nov. and *b*, *T. rosea* Macq.
Text-figure 8.—Egg of *T. rosea* Macq.

These differences are shown in Text-fig. 6 and are small, but easily seen in mounts, and they are quite constant throughout quite good series of the various species and varieties. It will be seen from the figure that *T. punctata punctata* Macq. and *T. punctata orientalis*, nov., differ in the shape of the distostyle, whereas *T. harrisoni*, nov. and the first named are closely similar. The first two are much alike in coloration and markings (at least there is a continuous series), while *T. harrisoni* differs markedly from either. On the other hand, *T. harrisoni*, nov., closely resembles *T. bivitta bivitta* Walk., but differs from it in genitalia. These differences would not be worthy of much consideration were it not for the fact that all the evidence strongly indicates that they are quite constant, and for the interesting distributional questions raised. The whole series is very difficult and much more extensive material must be investigated before definite conclusions can be reached. The arrangement here given represents a

distinct advance in our knowledge of this series, but it must be understood that it is only tentative and may require considerable modification before finality is reached.

Female genitalia.

The lamellae of the ovipositor not only offer interesting evidence of generic relationships, but also supply a character by which the *rosea* group may be separated from the rest of the genus. In the *rosea* group (Text-fig. 7, *b*) each lamella is flattened and leaf-like and is short and broad in side view. In the other species it is more elongate and parallel-sided and is curved so that the apposition of the two lamellae forms a longitudinal tube. The members of the *costalis* subgroup in general have much shorter lamellae than do those of the *novae-hollandiae* subgroup, but the difference is not sufficiently marked to form a useful character.

Coloration and markings.

For the separation of many species one must rely on small differences of colour and pattern, and to a small extent on differences in size and general body shape. This renders descriptive work rather difficult, because one frequently finds that two series are obviously distinct when placed side by side, and yet it is almost impossible to give an adequate word picture of the differences between them. A careful study of a long series of a number of species points definitely to two conclusions: firstly, that the coloration and pattern of specimens of a given species from the one locality are in general remarkably constant, and secondly, that specimens of a species from one locality often differ markedly from those from another area. An important fact bearing on the justifiability of using these characters is that several very closely related species may occur in one locality. For example, at Barrington Tops several closely related species of the *punctata* series were taken, all occurring at the same time in the same situation. In the case of three of these we have sufficient numbers to demonstrate their uniformity. In the absence of any linking forms, one feels bound to give them separate specific rank, and it seems reasonable to extend our conclusions, based on this and other experiences of the uniformity of various species, to those of which we have but few specimens.

The sexes are often similar in appearance, but in many species there is more or less dimorphism, and in such cases it is frequent to find that the males are readily separable, while the females are difficult to distinguish (e.g., *T. rosea* Macq. and *T. cques* Schin.). There is rarely any very great variation in size, long series sometimes showing not more than a millimetre or two difference, and in such cases the finding of one or two very small individuals may raise the suspicion that one is dealing with a distinct species. One has, however, refrained from using size alone as a character of value, although it is often useful for purposes of quick identification, as in the case of *T. fusca*, nov., which may be separated at a glance from its allies by its very small size.

Distribution.

Two distinct sets of facts are here discussed: firstly, the distribution of the various species throughout Australasia, and secondly, the seasonal distribution, about which there is some interesting information. These will be taken up separately. Apart altogether from its interest in relation to a possible Antarctic

connection with South America, the genus *Trichophthalma* is one of the most suitable in the whole Diptera Brachycera for the study of local distributional problems. The very plasticity which makes systematic work so difficult, takes on an added interest when looked at from the point of view of the effect of isolation and of varied environment. Studies of the distribution of, and relationships between, species in different parts of Australia also lead to interesting conclusions which may have a more general application. It is necessary, however, to emphasize that, although practically all the material in Australia has passed through my hands, the available evidence does not permit of more than tentative conclusions being expressed, and these are put forward here to interest others in their investigation rather than in their possible application.

The evidence strongly indicates that the centre of recent development of the genus is in eastern New South Wales, whence it has spread to Banks Island in the north, to Tasmania in the south, and also to the south-western corner of Western Australia. The last mentioned area presents certain special features, which will be taken up later, the western limit for the present purpose being taken as the eastern half of South Australia. This dispersal from an eastern centre is best demonstrated by considering the fauna of each of the States separately.

The part of New South Wales especially to be considered includes the Eastern Divide and the country to the east of it. Twenty of the thirty known species occur in this area and the number of individuals greatly exceeds two-thirds of the whole collection. One species, *T. fusca*, nov. and one subspecies, *T. punctata punctata* Macq. are only known from west of the Divide and really belong to other States, but the remainder are dominantly New South Wales species. This part of the country may be divided into two areas, the highlands and the coastal zone, presenting different conditions and showing marked differences in their faunas. The *rosea* group is practically restricted to the coast, only occasional specimens of *T. albimacula* Walk. and *T. laetilinea* Walk. being known from the mountains. The *novae-hollandiae* subgroup is well known both from the coast and from the mountains and also extends a little to the west of the Divide. These flies are, however, much more abundant on the mountains and *T. nigrovittata*, nov., is not known from the coast as yet, although it occurs on the coast of Queensland. *T. costalis* Westw. is equally prevalent in both areas, but the series in general is a dominantly mountain one, as is also the *punctata* series, although two species, *T. bivitta bivitta* Walk. and *T. confusa*, nov., are purely coastal. The first is represented in the mountains by *T. bivitta nigricosta*, nov., but nothing corresponding to *T. confusa*, nov., has yet been found there. An important fact bearing on this distribution and on the differences in prevalence of the different species at different times is that at the beginning of the season there is an abundance of attractive flowering plants on the coast and few or none on the mountains, while, later on, the highlands are rich in *Leptospermum*, the most attractive of all, while the coastal flowers are not so numerous or so attractive. This seems to be the most important factor underlying the differences in prevalence, but there is also evidence of a direct climatic influence, a fairly moist climate with mild temperatures being most favourable. In general, spring on the coast and midsummer on the mountains present fairly similar conditions and in both the Trichophthalmas abound, but the faunas of the two are quite distinct, the first having only the *rosea* group, while the second has all the rest. The coastal fauna in the middle of summer consists mainly of

the hardier of the species common on the mountains, together with a small special development.

Queensland possesses ten of the New South Wales species, which gradually die out as one proceeds north, the *rosea* group reaching the Johnstone R. (*T. eques* Schin.), the *costalis* subgroup extending as far as the Endeavour R. (*T. punctata orientalis*, nov.), while *T. novae-hollandiae* Macq. extends as far as Banks Island. Three of the species in this State are not known from New South Wales; *T. bancrofti*, nov., is nearly related to *T. novae-hollandiae* Macq. and is not yet known south of Brisbane. While it may turn up later in New South Wales, there is no room for doubt that it is typically a Queensland species, as is probably also *T. fusca*. Of the other two species, *fulva* Walk. and *intermedia*, nov., our knowledge is too scanty to warrant their consideration. In general the Queensland fauna is a very impoverished replica of that of New South Wales, except that the *novae-hollandiae* subgroup reaches as great, or possibly a greater, degree of development.

The Victorian fauna is also an impoverished one, there being only eight species known, all but one variety being typical New South Wales forms. The case of *T. punctata* Macq. is interesting; subspecies *orientalis*, nov., is abundant in eastern New South Wales and rare in Victoria, while subspecies *punctata* Macq. is known only from one specimen from west of the Divide in New South Wales, but is not uncommon in Victoria. Tasmania possesses only *T. punctata punctata* Macq., this species being abundant there. This State has been sufficiently well collected to make it certain that the other species are exceptionally rare, if they occur at all. It is a matter of considerable interest that the marginal forms, *T. novae-hollandiae* Macq. in the north and *T. punctata* Macq. in the south, are not primitive unsuccessful species pushed to the periphery, but amongst the most successful, numerous and wide-spread in the whole genus. There is every indication of a radial dispersal from eastern New South Wales of a type that is the reverse of that which holds good for the mammals, which is unexpected, for it is difficult to understand why this genus should not repeat in miniature what is said to hold good on a larger scale in other groups.

South Australia in turn has only a very small number of the New South Wales species, only three, or possibly four, of these being known; in addition the Tasmanian *T. punctata punctata* Macq. also extends as far as South Australia. There is, however, a greater development of endemic species, which is what one would expect owing to the greater distance from the centre. *T. subcostalis*, nov., probably replaces the eastern *T. rufonigra*, nov., and *T. griseolineata*, nov., is the South Australian representative of the *nicholsoni* type, while *T. variolosa* Licht. cannot be placed at present, but links up with *T. eques* Schin. or *T. albimacula* Walk.

The Trichophthalma fauna of Swanland, or south Western Australia, is very interesting, but at present very scanty, there being only six species recorded, two of which form a characteristic series, while the others are sharply differentiated from their eastern relatives. The most striking feature of these species is the great elongation of the proboscis and the reduction of the labellae. The *leucophaea* series is separated, in addition, by the abdominal markings and comes nearer to certain Chilian species than any of the other Australian species. Three species are represented in other parts of Australia, *T. costalis costalis* Westw. being replaced in the west by a well marked subspecies which is almost worthy of separate specific rank, while *T. ruficosta*, nov., and *T. grisea*, nov., are

specifically distinct from, but clearly related to, the eastern *T. confusa*, nov., and *T. primitiva* Walk. If one excludes *T. fulva* Walk., the distribution of which is somewhat anomalous, the evidence points to a prolonged isolation from the eastern species in an area which has been considered to represent ancient Australia. There is no evidence, however, that the Western Australian Trichophthalmas are archaic; on the contrary, those that show affinities with the eastern species are more highly specialized than their eastern relatives in the length of the proboscis and in wing and body markings. The indications are that they are derived from the eastern species and not the reverse, and that they form an earlier and longer separated element of the radial dispersal from New South Wales.

The conclusions expressed above are open to the serious objection that the different areas have been studied to very different extents, eastern New South Wales being especially well collected, and it may be suggested that the differences met with may well be explained on these grounds alone. I have had this possibility clearly in mind throughout this study and have endeavoured to check my conclusions by reference to separated localities which have been fairly well collected, Brisbane for example, and I am convinced that there is a good deal more in the differences met with than can be explained in this way, although I fully expect new records and species to turn up, not only in the other States, but in New South Wales also.

There is no indication at present as to the mode of origin of the groups and subgroups, but within the series there is considerable evidence of the part played by isolation in the evolution of the species. There are three sets of cases indicating separation for varying lengths of time. There is in the first place the simple effect of long distance separation without any barrier. The modifications at the extreme ends of a continuous distribution would be slow in development, because of the slight amount of mingling that would inevitably occur. The endemic South Australian species are the best instances of this type and the *leucophaea* series is probably in part the result of the same process, but of longer duration. Another factor, however, enters here, namely, the development of a barrier which has probably completely isolated the Swanland species and which has consequently allowed them to differentiate from the eastern forms more rapidly than when they were in actual contact. Some such additional factor is necessary in order to account for the unique character of the fauna of Swanland. This barrier is the desert, the country along the Great Australian Bight having become progressively more arid since the close of the Pleistocene. There is no evidence that any of the Australian species are adapted to even moderately arid conditions. There is, however, a good deal of evidence that during the Pleistocene this area was well watered and was probably well suited for the development of Nemestrinids, and the western species may have reached their present home then (or possibly earlier, but there is no indication of what the climate was like earlier than the Pleistocene). Another post-Pleistocene barrier which has led to an interesting development is the separation of Tasmania from the mainland. All, or nearly all, of the Trichophthalmas must have been driven out of Tasmania during the Pleistocene, when the temperature was some ten degrees, F., lower than at present and the climate fairly inhospitable. *T. punctata* Macq. either survived in Tasmania or invaded it just before its final separation and there developed into the particular subspecies found there. This form has reinvaded the mainland, but none of the mainland species have reached

Tasmania since the Pleistocene. The explanation of this is found in a study of the wind-rose for Melbourne, when it is seen that the prevailing winds during the months when the Trichophthalmas are on the wing are from the south, an interesting correlation of distribution with metereological conditions.

The third type of isolation is more recent and less complete than those described above. It consists in the splitting of a species into sections separated on different mountain tops, or part on the coast and part on the mountains, the greater environmental differences in the latter case producing a more marked effect. In the first instance the differences found, though apparent enough when dealing with long series of specimens, are not sufficient to warrant even subspecific distinction; *T. rufonigra*, nov., is a good example of this type, the coloration of the abdomen in the males, and of the wings in both sexes, differing noticeably between specimens from Kosciusko and those from Barrington Tops. The two subspecies of *T. bivitta* illustrate the second type.

It will be observed that the evidence presented above indicates that many of the species are not earlier than the Pleistocene in age, and this conclusion is supported by the systematic studies, there being every indication that the species are still in a state of flux and have not reached the stable condition seen in many other groups. The genus is an old one, and the groups and subgroups are well stabilized, but the species have apparently been undergoing marked changes and development in fairly recent times, possibly owing to the stimulating climate of the southern half of eastern Australia during and immediately after the Pleistocene.

One other question remains to be considered. In many animals distributed along the east coast of Australia, northern specimens differ markedly from the southern, and the same holds good for *T. nigripes* Macq., the differences found being dealt with fully under the description of that species. There are indications that further material will reveal a similar state of affairs in some other species.

While the effect of isolation has been stressed above, this is by no means the only factor involved in the evolution of the species, but it is the only one of which evidence can be produced at present. It is limited to the instances and conditions described and can hardly be made to apply, for example, to the bulk of the New South Wales species. The other factor or factors are, however, quite unknown.

The differences in seasonal occurrence, as well as distribution, between the *rosea* and the *costalis* groups have been mentioned above. There is a certain amount of information available as to the seasonal limits of the different species, which it is worth while summarizing here. Most of our data comes from the New South Wales species and especially, in the case of the *rosea* group, from those species occurring at the Royal Zoological Society's Biological Station at National Park, where a particular study of this question was made. The season in New South Wales may be divided into two parts with a definite gap between, the month of October being practically a blank as far as Trichophthalmas are concerned. August and September on the coast are entirely taken up by the *rosea* group, none of the other species appearing at this time. Each species has a season of about four or five weeks, the period of maximum prevalence being much shorter. The species appear and reach their maximum in a definite order. Thus, while three or four species may be taken together at almost any time in these months, the relative numbers of the species taken at different times vary markedly; for example, in the middle of August one sees a great number

of *T. rosea* Macq., many *T. primitiva* Walk. and a few *T. eques* Schin. and *T. albimacula* Walk.; in the latter part of September, on the other hand, *T. rosea* Macq. and *T. primitiva* Walk. are only represented by occasional ragged stragglers, while *T. eques* Schin. is commoner and *T. albimacula* occurs in fair numbers together with *T. ricardoae* Licht., which was not seen earlier. The order of appearance is: *T. primitiva* Walk., *T. rosea* Macq., *T. albimacula* Walk., *T. eques* Schin., *T. ricardoae* Licht., with *T. laetilinea* Walk. last, according to the records of this species which I have not taken myself. The season of this group at National Park coincides with that of *Epacris microphylla*, their favourite food plant in that locality. This is, however, not their only control, for at Woy Woy they feed on *Leptospermum* sp. and disappear long before the flowers are done. The climatic factor is probably the final control in this group.

The *costalis* and *novae-hollandiae* subgroups are on the wing in coastal areas from the end of October to the end of January. There is much less information as to succession of species, but the order seems to be—*punctata* series, *costalis* series, *novae-hollandiae* series, with a certain amount of overlapping. In Queensland, members of the *novae-hollandiae* subgroup have a much more extended season, the range being from October to April. It must be remembered that this subgroup has perhaps its greatest development in South Queensland and that it is the most adaptable of all the Trichopthalmas to different climatic conditions. For most species, however, the indications are that the time of appearance in Queensland is rather earlier than in New South Wales. On the mountains the season is distinctly later than on the coast, great numbers of Trichophthalmas being on the wing in February. A succession of species may also be found for the mountain forms, but the evidence is not yet sufficient to draw any definite conclusions.

Habits.

These flies are usually captured feeding at flowers. They are very selective, only one or two species of plant being attractive in any one locality. On the Hawkesbury Sandstone heath in early spring, when there is an abundance of flowering shrubs, practically the only one frequented is *Epacris microphylla*. Grass-trees (*Xanthorrhoea* sp.), *Leucopogon* sp. and *Sprengelia* sp. are occasionally visited for very short times. *Crowea saligna* was in one locality very attractive to *T. eques* Schin. In other types of country, such as the low Pleistocene sand-flats at Woy Woy, *Leptospermum* grows thickly and is very attractive. Members of this genus are also the most attractive plants on the mountains later in the season. On the coast in the middle of summer *Kunzia*, *Angophora* and *Eucalyptus* flowers are the ones visited, but they never attract such numbers as does *Epacris microphylla* or the Leptospermums. When feeding, the insect grasps the flower, or the stem just below it, with its legs and keeps its wings vibrating rapidly, but not so rapidly as when in flight, the note produced dropping markedly in pitch each time the fly touches a flower. This is particularly well illustrated in Pl. I, Fig. 4. I have never seen Trichophthalmas actually hovering while feeding, the plant in all cases being grasped by the legs. It is very rare, however, to see the wings come to rest. The fly stays two or three seconds at each flower and then quickly flies to another, twenty to thirty flowers being visited in a minute. The feeding may be kept up for several minutes and almost all the attractive flowers in a patch visited before the insect leaves it. They are very easily disturbed by any sudden movement and disappear in a

flash. This description of the feeding habits indicates the great difficulties encountered by Mr. Nicholson in photographing these insects alive and the patience and dexterity necessary in order to get an exposure.

Males are frequently seen playing and hovering in the air when not feeding, but one rarely takes a female at such times. Their loud, high-pitched, characteristic note usually attracts attention to them before they are seen. Their circling and twisting movements, indulged in at irregular intervals whether disturbed or not, are dazzling in their swiftness and their capture would be extremely difficult were it not for the fact that they almost invariably return immediately to the spot where they had previously been hovering. When feeding on flowers, however, if disturbed they disappear in a flash and never return. This hovering habit is not uncommon in other Diptera, but reaches its highest development in the Trichophthalmas.

These habits are approached by *Trichopsidea oestracea* Westw., but are in marked contrast with those of *Exeretoneura maculipennis* Macq., as was well seen at Barrington Tops, where both *Trichophthalma* and *Exeretoneura* were abundant, the latter being a lethargic, slow-moving type and not feeding on the flowers.

Nothing is known of the life history of any of the Australian Nemestrinids. Attempts to find the larvae in situations where the adults are abundant have all failed, numerous Asilid and Therevid larvae being turned up, but nothing that could be assigned to the Nemestrinidae. There is little indication from the habits of the adults as to what to look for, but White's (1914) record of the habit of the female *T. punctata* Macq. of resting on the young wattles may possibly have a bearing on their egg-laying habits. We have seen females of *T. costalis* Westw. in a sandy locality resting on bracken or hovering and flying about close to the ground, but they did not give any other indication of possibly being about to oviposit. Studies of seasonal distribution strongly indicate that there is not more than one brood each season, no species being known to appear twice in one year. Several females of *T. rosea* Macq. were brought to the laboratory alive and in one case eggs were laid, but to date (two months later) have not hatched. They were scattered in little irregular masses all over the lower part of the sides of the jar and on the sand at the bottom. The contrast with the neat egg-masses of Tabanids ovipositing under similar conditions is very marked; this, however, may not be the natural method. The egg (Text-fig. 8, p. 500) is pale creamy-white in colour, without any sculpturing or marking, torpedo-shaped and distinctly more bluntly rounded at one end than the other. The eggs appear to be sticky and adhere to one another, to the sand, and to the sides of the vessel. An average egg is 1.30 mm. long by 0.22 mm. wide.

Systematics.

The different groups and subgroups are easily recognized, but it is much more difficult to recognize some of the closely related species, especially in the *punctata* series of the *costalis* subgroup. While the primary subdivision is on antennal characters, there are sufficient differences in other respects to make the position of an insect clear even when the antennae are missing, and these are given in brackets in the following key, which (except for the genitalia, which are dealt with fully on p. 499) serves also as a definition of the groups and subgroups. It is interesting to note that species from different groups or subgroups may resemble one another strongly in general appearance, for example,

T. intermedia, nov. and *T. bancrofti*, nov., *T. rufonigra*, nov. and *T. novae-hollandiae* Macq., while *T. nigrovittata*, nov. and *T. leucophaea* Walk. have a superficial resemblance to species of the *rosea* group. The *costalis* subgroup is fairly uniform, but I have divided it into three series, partly for convenience and partly to indicate the relationships of the species. There are no very marked characters separating these series and a linking form is seen in *T. intermedia*, nov., which has been placed provisionally in the *costalis* series. The *novae-hollandiae* subgroup is very uniform, as is also the *rosea* group, with the exception of *T. laetilinea* Walk. and *T. ricardoae* Licht., which form a series apart from the rest and show interesting characters linking them with the *costalis* group. My *costalis* subgroup corresponds with Hardy's Group 1, the *novae-hollandiae* subgroup with his Group 2, and the *rosea* group with his Groups 4, 5 and 6. Groups 4 and 5 of Hardy may be reasonably separated as series, but Group 6 (*T. primitiva* Walk.) should go in with the species of Group 4, to which it is closely related in all bodily characters.

Key to groups and subgroups.

A. Third antennal segment conical, never divided by a sulcus near its base. (Palpi always obvious, never obscured by hair; wing with M_{3+4} continuous, or nearly so, with rest of oblique vein.) ..... *costalis* group.
   a. Palpi slender, second segment short, acuminate, apical pit small ..... *costalis* subgroup.
   b. Palpi stout, second segment as long as first and stouter than it, apical pit large and obvious ..... *novae-hollandiae* subgroup.

B. Third antennal segment long, cylindrical, with well-marked sulcus near its base. (Palpi greatly obscured by hair and vein M_{3+4} markedly displaced towards wing-root, or abdomen with shining pale transverse markings or spots) ..... *rosca* group.

Key to species of the costalis *subgroup.*

1. Brown or greyish nearly concolorous species, abdominal markings irregular if contrasted, palpi moderately slender (*costalis* series) 3
   Fulvous species, with strong contrast between markings and ground colour of abdomen, palpi very slender 2
2. Proboscis more than three times the head length, labellae small and inconspicuous (*leucophaea* series) 12
   Proboscis at most twice the head length, labellae at least moderately prominent (*punctata* series) 13
3. Abdomen without transversely disposed spots, at most with longitudinal darker blotch 4
   Abdominal segments with transversely disposed darker spots, on some segments linked by a basal dark band 11
4. Thorax grey, abdomen yellowish with irregular median grey stripe .. *intermedia*, nov.
   Thorax and abdomen dark brown 5
5. Males 6
   Females 9
6. Abdomen with prominent basal band of white hairs 7
   No such band 8
7. Apical third of wing clear white, Western Australia ..... *costalis apicalis*.
   Brown coloration of wing fading gradually to apex, East Australia ..... *costalis costalis* Westw.
8. Very large dark species with grey pleurae. Eastern Highlands ..... *rufonigra*, nov.
   Medium sized species, reddish-brown in colour, pleurae white, South Australia .. *subcostalis*, nov.
9. Proboscis more than twice the head length, labellae inconspicuous, Western Australia ..... *costalis apicalis*, nov.
   Proboscis less than twice the head length, labellae conspicuous, Eastern Australia.. 10
10. Large dark species with grey pleurae ..... *rufonigra*, nov.
    Medium-sized dull brown species, pleural hairs white ..... *costalis costalis* Westw.

11. Very small reddish-brown species, proboscis long, ninth tergite of male as in Text-fig. 6, *j* ..... *fusca*, nov.
Medium-sized greyish-brown species, proboscis short, ninth tergite not unusual ..... *obscura* Westw.
12. All abdominal stripes about equal in breadth ..... *leucophaea* Walk.
Brown side margins and black median stripe very narrow relative to the grey intermediate areas ..... *longirostris*, nov.
13. Abdomen with narrow median black stripe or row of small spots, side margins and posterior edges of segments never with any dark markings 14
Abdomen with dark median stripe, side margins always, and apical edges of segments often, with dark markings 15
14. Thorax brown with two indistinct paler stripes, abdomen orange to drab with small median black spots ..... *punctata* Macq.
Thorax dark brown with two prominent paler stripes, abdomen bright orange with black band ..... *fulva* Walk.
15. Thorax dark brown or black, with two or three narrow yellow or grey lines, male genitalia as in Text-fig. 6, *g* 16
Thorax velvety-black with gold hairs especially at the sides, genitalia various ... 19
Thorax dark grey, unmarked, abdomen wtih dark median and sublateral stripes ..... *ruficosta*, nov.
Thorax brown, pale longitudinal stripes equal in width to the dark median part, abdomen with dark median and lateral stripes, genitalia as in Text-fig. 6, *d* ..... *confusa*, nov.
16. Sides of scutum with pale zone small and very obscure 17
Pale zone at sides of scutum forming a prominent broad band extending above wing root 18
17. Scutum with three very narrow yellow lines ..... *trilinealis*, nov.
Scutum with two broader greyish lines ..... *griseolineata*, nov.
18. Abdomen pale fawn, with broad black median stripe and prominent black side margins ..... *nicholsoni*, nov.
Abdomen yellowish-brown, with narrow median stripe and inconspicuous black markings at sides ..... *dubiosa*, nov.
19. Male genitalia as in Text-fig. 6, *e* 20
Male genitalia as in Text-fig. 6, *f* ..... *harrisoni*, nov.
20. Costa pale brown, very small species ..... *bivitta bivitta* Walk.
Costa very dark brown, small medium species ..... *bivitta nigricosta*, nov.

Note.—It has been very difficult to construct a satisfactory key to this subgroup and determinations made by means of it should always be checked by a reference to the original description. *T. intermedia*, nov., and some Tasmanian specimens of *T. punctata* Macq. may be placed in their wrong series to begin with, but they will not then run down to any of the species. In both, the palpi are a help and in the latter the single row of clear-cut black abdominal spots is quite characteristic, even though the ground colour may be fairly dark. My *T. confusa* is the *T. fulva* Walk. of many workers and is the common coastal species of this series in New South Wales. *T. ales* Newm. is omitted.

Key to species of the novae-hollandiae *subgroup.*

1. Abdomen orange with broad black median stripe and black side margins ..... *nigrovittata*, nov.
Abdomen not as above 2
2. Sides of thorax and abdomen with bright mustard-yellow hairs; ninth tergite of male as in Text-fig. 6, *k* ..... *nigripes* Macq.
Lateral hairs at most dull yellow; ninth tergite of male as in Text-fig. 4, *d* 3
3. Rich to dark brown concolorous species ..... *novae-hollandiae* Macq.
Thorax grey, abdomen yellowish with irregular grey median stripe .. *bancrofti*, nov.

Key to species of rosea *group.*

1. Palpi greatly obscured by hair, vein M_{3+4} considerably displaced, abdomen without bright transverse markings (*rosea* series) 2

Palpi easily seen, vein M_{3+4} not so markedly displaced, abdomen with bright transverse markings (*laetilinea* series) 7
2. Abdomen with well-defined pale stripes or spots 3
Abdomen dull grey with inconspicuous darker markings 6
3. Thorax dark brown with two narrow grey lines ..... *albimacula* Walk.
Thorax grey with broad black median stripes and less marked black lateral stripes .. 4
4. Abdomen black with yellow spots ..... *variolosa* Licht.*
Abdomen black with two broad grey stripes 5
5. Foxy-red line at side of thorax and terminal abdominal segments in both sexes, in male all under surface rose-pink ..... *rosea* Macq.
No red or rosy colour, margins and under surface pale yellow to greyish-white in both sexes ..... *eques* Schin.
6. Abdomen with dark transverse bands ..... *primitiva* Walk.
Abdomen with dark median round spots ..... *grisea*, nov.
7. Large species, abdomen with golden transverse bands, bulb of aedeagus rounded ..... *laetilinea* Walk.
Small species, abdomen with paler transverse bands or spots, bulb of aedeagus bilobed ..... *ricardoae* Licht.

* I have not seen this species.

Descriptions of species.

A.—*costalis* subgroup.

Trichophthalma costalis costalis Westwood.

Nemestrina (*Trichophthalma*) *costalis* Westwood, 1835.—? *Rhynchocephalus ales* Newman, 1841.—*Trichophthalma albibasis* Walker, 1857.—*Hirmoneura Heydenii* Jaennicke, 1867.—*Trichophthalma fuscipennis* Thomson, 1869.—*T. ochropa* Thomson, 1869.—*T. costalis* Westw. of authors.

Westwood, 1835, p. 448; 1838, p. 86.—Newman, 1841, p. 220.—Walker, 1857, p. 134.—Jaennicke, 1867, p. 336, Pl. 43, fig. 7.—Schiner, 1868, p. 112.—Thomson, 1869, p. 447.—Lichtwardt, 1910*a*, pp. 372, 375, 381, 384, 385.—Hardy, 1924, pp. 451, 452, 453.

"Thorace fusco; capitis facie alba; oculis piceo-pubescentibus; abdomine rufescenti-fusco; basin et apicem versus corporeque toto subtus pubescentia albo-cinerascenti indutis; pedibus rufescentibus; antennarum articulis terminalibus nigris; alis elongatis; costa late fuscanti; proboscide nigro; capite paullo longiori. Long. corp. (probosc. excl.) lin. 7. Exp. alar. lin. 17.

"Habitat in Nova Hollandia. In mus. nostr. Communicavit Dom. Shuckard."

I have divided this species into two, separating the Western Australian form as a distinct subspecies.

Medium-sized, fairly stout-bodied, dark reddish-brown species; wings smoky with anterior half dark brown; legs brown; abdomen of male with characteristic transverse basal band of dense whitish-grey hairs.

♂. Eyes dark reddish-brown, not quite meeting at apex of facial triangle, hairs dark brown above, almost white below; frons grey, sometimes almost white, with fine white hairs, keel well marked, partly brown; face projecting below antennae, sides of oral margin pale brown, underface with dense long shaggy white beard, yellowish in front. Antennae with first segment pale yellowish-brown with white hairs, second segment brown with black hairs, third segment and style black. Proboscis a little longer than the head, fairly stout and with prominent labellae; palpi (Text-fig. 2, *c*) with basal segment dark brown, apical segment bright brown, thin; apical pit easily seen, whole palp covered with sparse short black hairs.

Thorax uniform dark reddish-brown, except for a pale spot on each side at medial end of the transverse suture, which is incomplete. Dorsum clothed

with short rather sparse brown hairs; hairs at side margins long and dense and mostly brown to grey in colour; an especially long tuft of hairs behind the wing root; scutellum dark reddish-brown, edged with long shaggy pale grey hairs. Pleurae white with long white hairs mixed with grey. Legs reddish-brown, knees pale, dorsal aspect of tibiae darker brown, tarsi darker, hind tibiae and tarsi darker brown. Wings long, rather narrow apically, somewhat smoky throughout, with the fore-border brown to apex of cell Sc, the colour extending a little behind R_{2+3} in the middle of the wing.

Abdomen short, broad, rather abruptly conical, dark reddish-brown with slightly paler side and hind margins to the segments and a darker centre, which is sometimes fairly apparent. Sides with dense pale grey hairs intermixed with a variable amount of brown; first segment and base of second with dense long shaggy greyish-white hairs forming a striking pale transverse band. Venter pale grey with short silky whitish hairs. Genitalia as in Text-fig. 4, *a*, *b*, *c*.

♀. Eyes separated by nearly the width of the ocellar triangle; keel on face not prominent, beard pure white; palpi more acuminate apically than in the male. Thorax and abdomen dull brown with no reddish tinge; hair tufts at sides of thorax, on scutellum and behind wing roots darker and less striking than in the male. Pale hairs at base of the abdomen not forming a striking band, sometimes hardly distinguishable, rest of abdomen with sparse short stout hairs only. Pleurae and venter with pure white hairs.

Length: ♂, body 14 mm., wing 15 mm.; ♀, with ovipositor extended, 15 mm. There are two very small males before me, which measure 11 and 9.5 mm., also a large male from Mt. Tambourine, Queensland, which is 16 mm. long; otherwise the size both of males and females is close to the average.

This subspecies is easily recognized in the male by the white base to the abdomen and by the way the brown colour gradually fades towards the apex of the wing. The separation of the related females is dealt with under *T. rufonigra*, nov.

The above description is based on a series of 27 males and 10 females from a considerable number of localities in the Eastern States. This subspecies is most abundant in the coastal districts and on the mountains of New South Wales and South Queensland, the most northern record being a male from Wide Bay, Queensland. There are also two males in the National Museum from Victoria, the localities being Oakleigh and Wilson's Promontory, and another in the Macleay Museum labelled South Australia without any further data. I have seen no specimens of the typical subspecies from Western Australia. In New South Wales individuals may frequently be seen, but never in great numbers. Their season is from the end of October to the end of December in coastal districts, rather later in the mountains. On coastal Queensland the season appears to be earlier. They have been taken feeding on *Leptospermum* and flowering Eucalypts, the males sometimes being seen hovering under trees. At Broken Bay, N.S.W., in December, this subspecies was feeding on the flowers of a Eucalypt about twenty feet in the air; the males spent a good deal of time hovering perfectly motionless in the air ten or twelve feet from the ground, but occasionally near enough to be captured. When the females had finished feeding, they came right to the ground and rested on the bracken or flew about over the sand.

With regard to the synonymy noted above, it is easy to determine all except *T. ales* Newm. *T. Heydenii* Jaenn. is admirably described and fits the male of this subspecies completely. Lichtwardt considers it to be a synonym of *T.*

punctata Macq., basing his conclusions on a male (which was apparently not the type) in the Stockholm Museum, but the description does not fit *T. punctata* Macq. and I believe his conclusion to be incorrect. Hardy records *Heydenii* Jaenn. from Western Australia and identified a pair in the Australian Museum as this species; this is a misidentification due to Hardy having mistaken Jaennicke's fig. 6 of *H. nemestrinoides* Jaenn. from Chili for that of *Heydenii* which was illustrated in fig. 7. The Chilian species bears an extraordinary resemblance to the pair in the Australian Museum. *T. ochropa* Thom. is difficult to place. Thomson says it is like *quadricolor* Walk. (= *punctata* Macq.) and, when describing *T. fuscipennis* Thom., which is an undoubted synonym of *costalis* Westw., he says it may be the male of *ochropa* Thom. Lichtwardt considers that *ochropa* Thom. is probably the female of *albibasis* Walk. (= *costalis* Westw.) and the description fits this species reasonably well. Hardy places it as a synonym of *T. fulva* Walk., but the description cannot be made to apply to any member of the *punctata* series.

Newman's description of his *Rhynchocephalus ales* is as follows:

"Instrumenta cibaria desunt: corpus breve postice acuminatum, lanuginosum, supra fuscum, subtus canum: alae longiores et (pleurumque basin versus) angustiores, fusco tinctae, regione costali satuatori: pedes testacei. (Corp. long. .6 unc., alar. lat. 2 unc.).

"Inhabits New Holland. A single specimen is in Mr. Shuckard's cabinet."

This description is quite inadequate; the species may be *costalis* Westw., as Hardy suggests, or the name must be eliminated as a *nomen nudum*, unless the type be discovered and redescribed.

Trichophthalma costalis apicalis, n. subsp.

♂. Readily recognized by the coloration of the wing, the brown and general smokiness ending abruptly, leaving the apical third clear white. It also differs from the typical subspecies in its larger size and in the proboscis, which is longer and slenderer, ending in small relatively inconspicuous labellae. The palpi are stouter and the apical pit wider. The band of shaggy hairs at the base of the abdomen is more grey in colour. Genitalia similar.

♀. Two females in Dr. Ferguson's collection are provisionally allotted to this subspecies, as no males of either the typical subspecies or of *T. rufonigra*, nov., have been found in Western Australia. The wing does not show the clear apical third seen in the male, but the size, proboscis and palpi are similar. In other respects it closely resembles the female of the typical subspecies.

Length: ♂, body 17 mm., wing 18 mm.; ♀, 18 mm. long.

While this form is easily separable, at any rate on the male, from the typical subspecies, it is obviously closely related and its true position is, in my opinion, more accurately defined by making it a subspecies, rather than by giving it separate specific rank, an arrangement which brings the distributional differences into due prominence.

Distribution.—Western Australia: 2 ♂♂ from Perth, 15th November, 1924, coll. Nicholson; 2 ♂♂, King George's Sound, no date, in the Australian Museum; 1 ♂ from Hamel, no date, in the Queensland Museum; 2 ♀♀, Mundaring, no date, in coll. Ferguson.

Holotype, a ♂ from Perth, 15th November, 1924, and allotype, a ♀ from Mundaring, both in the Macleay Museum. Paratypes in collections named above.

TRICHOPHTHALMA RUFONIGRA, n. sp.

A large, stout, dark brown species; wings smoky with brown fore-border; legs rich reddish-brown; abdomen of male with reddish tinge, no band of white pubescence.

♂. Eyes brownish-black, not quite meeting below ocelli, hairs brown above, paler towards lower margin. Frons yellowish-grey, keel not prominent, but with a long vertical median incision which is brown and spreads into a brown patch between the antennae; face projecting slightly, oral margin brown, underface grey with dark brown almost black beard. Antennae like *T. costalis costalis* Westw. Proboscis slightly longer than the head, stout, labellae prominent; palpi with second segment clearly marked off, apical pit larger than usual, with a small projection on the dorsomedial aspect of its edge.

Thorax dark brown, with a pale patch at the medial end of the transverse suture, covered dorsally with sparse short black hairs. Side margins with dense brown hairs, postalar tuft brown, scutellum reddish-brown with dark brown marginal hairs. Pleurae brownish-grey with brown hairs. Wings long, somewhat smoky, fore-margin broadly dark brown. Legs rich reddish-brown, darker than in *T. costalis* Westw., distal tarsals almost black; hind tibia and tarsus much darker.

Abdomen slightly longer than broad, dark reddish-brown with almost black side-margins and broad median band. Base of second segment with a narrow zone of paler hairs, rest of abdomen with sparse fairly long black hairs; sides with dense black hairs. Venter greyish-brown with brown hairs. Genitalia as in *T. costalis* Westw.

♀. Eyes separated by width of ocellar triangle, beard pale brownish-grey. Thorax and abdomen a duller brown than in male, hair at side margins much scantier and of a more greyish tint. Pleurae and venter grey with paler greyish-brown hairs than in the male. Legs and wings as in male.

In the Kosciusko specimens the beard, pleurae and venter are much paler than in the typical form from Barrington Tops, and the reddish coloration of the abdomen of the male is much more prominent. This is very suggestive of an early stage in the development of subspecies by isolation on two separated mountain tops. This species is readily distinguished on the male from *T. costalis* Westw. by the absence of the white basal band to the abdomen. Both sexes can be immediately separated from *T. novae-hollandiae* Macq., to which this species bears a strong superficial resemblance, on the palpal characters.

Length: ♂, body 19 mm., wing 20 mm.; ♀, body 21 mm. The smallest specimen before me is a ♀ from Hartley and is 18 mm. long, which is considerably larger than the largest specimen of *T. costalis costalis* Westw.

Distribution.—New South Wales: Barrington Tops, early February, 1925, 12 ♂♂ and 19 ♀♀, feeding on *Leptospermum* flowers; Kosciusko, 11th February, 1924, 5 ♂♂ and 7 ♀♀, some feeding on *Leptospermum*, coll. Nicholson; Hartley, 29th December, 1923, 1 ♀, on *Leptospermum*; Mittagong, 30th November, 1924, Goldfinch, 1 female in Coll. Ferguson; Ulong, E. Dorrigo, 1st February, 1919, Heron, 1 ♀ in the Australian Museum. This species is apparently restricted to high altitudes and appears usually towards the end of the season. At Barrington Tops, it and *T. novae-hollandiae* Macq., which it closely resembles superficially, were very abundant, flying and feeding actively during any spells of sunshine.

Holotype ♂ and allotype ♀ from Barrington Tops, early February, in the Macleay Museum.

While the males of *T. costalis costalis* Westw., *T. costalis apicalis*, nov., and *T. rufonigra*, nov., are easily separable, the females are closely similar, but may be distinguished by a comparison of the following points:

(*a*) *T. costalis apicalis*, nov., closely resembles the typical subspecies in coloration, etc., but may be separated by the long slender proboscis and small labellae; it is also slightly larger and has a different distribution.

(*b*) *T. costalis costalis* Westw. has a short stout proboscis with prominent labellae, is a medium-sized species, has a pure white beard, pleurae and venter with white hairs, and has the apical pit of the palp small.

(*c*) *T. rufonigra*, nov., also has a short stout proboscis with prominent labellae, but is recognized by its much larger size, darker colour, wider palpal pit, and by its beard and pleurae which are always more grey or brown than white, even in the pale Kosciusko specimens.

Trichophthalma subcostalis, n. sp.

A median sized species with dull brown thorax and reddish-brown abdomen without dense basal white hairs. Wings smoky, with costal margin faintly suffused with brown. Legs yellowish-brown.

♂. Eyes brownish-black, close together below ocelli but more separated than in either *T. costalis* Westw. or *T. rufonigra*, nov., hairs brown above, pale below. Frons pale yellow, no keel but a slight incision in the mid-line; face pale yellow, oral margin yellowish-brown with sparse brown hairs; beard yellowish-white. Antennae like *T. costalis costalis* Westw., but second segment with pale hairs and third segment and style dark brown rather than blackish. Proboscis rather longer than head, moderately stout, labellae rather small but better developed than in *T. costalis apicalis*, nov.; palpi light brown with apex pitchy, otherwise like *T. costalis costalis* Westw.

Thorax dull brown with black hairs (parts of the thorax of this specimen are irregularly black, apparently due to greasiness). Side margins with fairly dense yellowish-grey hairs; postalar tuft long, of same colour; scutellum brown with yellow and brownish marginal hairs. Pleurae pale grey with white hairs. Wings somewhat smoky, slightly suffused with brown along the anterior margin. Legs yellowish-brown, tarsi darker, hind tibia and tarsus darker brown.

Abdomen longer in proportion to its breadth than in the species described above, reddish-brown in colour, with an irregular median black band; covered with sparse brown hairs, somewhat longer and paler at the base; side margins with fairly dense brownish-yellow hairs. Venter ochreous, with yellow hairs. Genitalia as in *T. costalis* Westw., but distostyle more acuminate apically.

Length: ♂, body 14 mm., wing 14 mm.

Holotype, the unique male from Tulka, Proper Bay, Eyre's Peninsula, South Australia, no date, E. Troughton, in the Australian Museum.

Recognized from *T. costalis* Westw. by the absence of the basal white band to the abdomen, and from *T. rufonigra*, nov., by its smaller size, pale beard and white pleurae, paler wing coloration, and by its paler coloured more acuminate palpi. I am at a loss to suggest any way by which the female may be recognized when found, and there is an element of doubt in my mind as to the validity of this species. It may prove to be a subspecies of *T. rufonigra*, nov., when more is known about it and its distribution.

TRICHOPHTHALMA OBSCURA Westwood.

Nemestrina (Trichophthalma) obscura Westwood.

Westwood, 1835, p. 448; 1838, p. 86.—Hardy, 1924, p. 451.

"Obscure cinerea; pedibus rufescentibus; facie alba; proboscide capite fere duplo longiori; alis ad costam tenuiter fuscantibus; ocello antico aliis remoto. Long. corp. (probosc. excl.) lin. 5½. Exp. alar. lin. 14.

"Habitat in Africa?—In mus. D. Hope."

A medium-sized brown to greyish species. Anterior border of wing suffused with brown. Abdomen brown to greyish-brown, with definite dark brown markings. Pleurae with pure white hairs. Legs brown to greyish-brown.

♂. Eyes reddish to dark brown, almost meeting below ocelli, hairs dark brown above, pale yellowish round lower border. Frons yellow with brown keel, epistoma brown in dark specimens; frons, keel and epistoma pure white in the paler broader specimens; beard pure white, anterior part varying from a tinge of yellow to dark brown. Antennae pitchy, basal segments with a variable amount of pale hoariness, pure white in some specimens. Proboscis a little longer than the head, stout, with prominent labellae; palpi brown with dark tip, varying to entirely pitchy-black.

Thorax brown to dark brown, with dark hairs. Side margins with dark grey mixed with paler hairs; postalar tuft similar; scutellum with dark hairs above, pale brown below hind margin. Pleurae pale grey with silky white hairs, intermixed with some grey ones in some specimens. Wings somewhat smoky, brown along fore-border which is very dark in the slender specimens. Legs in dark specimens bright brown, dorsal aspects of tibiae and tarsi darker, hind tibia and tarsus dark brown, almost black on distal tarsals; in the paler specimens the legs are a pale greyish-brown.

Abdomen very variable in length, brown to greyish-brown in colour, with definite darker markings which take the form of three large transversely disposed spots on each segment; these spots are joined on the second and sometimes on the subsequent segments by a broad transverse basal dark band; the spots are somewhat variable in extent in different specimens, but are always easily seen and are a useful character. Hairs on abdomen dark brown, with a more or less evident transverse zone of pale hairs at the base of the second segment, never, however, resembling the condition seen in *T. costalis* Westw.; side margins with dark brown hairs with small patches of paler ones. Venter greyish-white with pure white silky hairs. Genitalia not unlike *T. costalis* Westw.

♀. As is usual, the lateral thoracic and abdominal hairs are less developed, otherwise this sex resembles the male in essential respects.

The extremes are represented, on the one hand by a pair from Barrington Tops, which are of slender form and dark colour, on the other by two males from the Dorrigo which are of short stout habit, pale colour, and also differ slightly in the genitalia, the middle part of the distal end of the ninth tergite being slightly incised instead of rounded. This appearance is due more, however, to a slight bending of the apical part than to an actual difference in outline. These two sets of specimens would be placed in distinct species were it not for the intermediates which we possess. The genitalic difference is very slight and not to be relied on without further data.

Length: Body 13 mm., wing 13 mm. This applies to all types. The width of the abdomen in the slender male is 5 mm. and in the stout one 6.4 mm., which sufficiently indicates the difference in form.

Distribution.—Queensland: Mt. Tambourine. New South Wales: Dorrigo (Ulong and Meldrum), Barrington Tops, Kendall, Terrigal. The dates of the highland specimens are early February, of the Terrigal specimen, January.

This species is recognized by the absence of a white band on the male abdomen, by the slender habit of the dark forms and the greyish-brown colour of the stout specimens, and especially by the definite markings of a darker colour on the abdomen.

The propriety of allotting the name *obscura* Westw. to this species is somewhat doubtful. The original description is vague and the locality doubtful. White, however, identified a specimen in Dr. Ferguson's collection as *T. obscura* Westw. and, since he may have seen the type, his determination may be accepted for the present, otherwise the name cannot be placed. It seems fairly certain that it is not an African species. Hardy queries *obscura* Westw. as a synonym of *costalis* Westw., basing his conclusion on White's identification; the species may, however, be readily separated from *T. costalis costalis* Westw. on the male, and almost as readily on the female, when good specimens are available.

TRICHOPHTHALMA FUSCA, n. sp.

A small brown species with abdominal spots. Proboscis long and with small labellae. Wings with fore-borders brown. Legs brown. Ninth tergite of male characteristic.

♂. Eyes dark brown, separated by the width of the anterior ocellus; hairs brown above, pale yellowish below. Frons and face yellowish-grey, in one specimen white; beard white. Antennae with basal segments light greyish-brown, third segment and style pitchy. Proboscis more than twice the length of the head, moderately slender, labellae small; palpi dark brown, second segment longer than usual in this group, but equally as slender.

Scutum and scutellum dark brown with dark brown hairs; side margins with mixed grey and creamy hairs; postalar tuft long and creamy; margin of scutellum with light brown hairs. Pleurae pale grey with creamy hairs (some specimens have the hair in front of the wing roots yellow, due, I think, to discoloration). Wings fairly clear, cells C, Sc and 1st R brown. Legs with basal half of femora yellowish, rest of legs rich brown, darker on tarsi.

Abdomen rather dark greyish-brown with large round median spots and lateral patches of the same colour. The abdominal hairs are long and are rather denser and paler basally than on the rest of the abdomen; side margins (somewhat rubbed in the type) with alternating patches of dark brown and creamy hairs. Venter pale grey with creamy hairs. Genitalia (Text-fig. 6, *j*) showing a marked difference in the shape of the distal end of the ninth tergite from the rest of the subgroup and resembling the condition found in the *novae-hollandiae* subgroup; males may be recognized even with a hand-lens by this character; the apical part of the distostyle is also somewhat differently shaped from the other species.

♀. Eye width equal to diameter of ocellar triangle and body not so hairy, otherwise exactly similar to male.

Length: ♂, body 10 mm., wing 10 mm. ♀ the same.

This species is readily recognized by its small size, abdominal spots, long proboscis, and ninth tergite of the male. Its nearest ally appears to be *T. obscura* Westw. which is much larger, has a short proboscis and different genitalia.

Distribution.—Queensland: Port Curtis, no date, 2 ♂♂ in the Macleay Museum; Gayndah, no date, a ♂ and ♀ in the Australian Museum. New South Wales: Pipers Flat, no date, a ♂ in the Macleay Museum.

Holotype ♂ and allotype ♀, both from Gayndah, in the Australian Museum. Paratypes, other specimens as above.

Trichophthalma intermedia, n. sp.

A large species of moderate stoutness. Thorax uniformly grey, abdomen brownish-yellow with an irregular median grey stripe. Legs brown, hind darker. Wings with fore border broadly brown. Superficially closely resembles *T. bancrofti*, nov.

♂, ♀. Eyes blackish-brown, almost meeting below ocelli in ♂, with dark brown hairs above, creamy below. Frons brown, covered with greyish-white bloom, bare, keel inconspicuous; face bright brown, with sparse short coarse black hairs; beard inconspicuous, creamy, brownish anteriorly. Basal segment of antenna brown, second black, both with coarse black hairs (a few yellow ones on basal segment in the female), third segment and style black. Proboscis a little longer than the head, stout and with prominent labellae; palpi dark brown, light brown on medial side of apical segment, with stout black hairs.

Scutum uniformly slate-grey, scutellum greyish-brown, both covered with sparse short black hairs. Sides of scutum with rather sparse black hairs mixed with some creamy ones; postalar tuft creamy; margin of scutellum with black hairs above, creamy below. Pleurae pale grey with tufts of creamy hairs. Legs bright brown, hind tibia and tarsus dark brown. Wings somewhat smoky, broadly brown basally, the colour extending to origin of R_{4+5} from the oblique vein and then fading rather abruptly; cells Sc and R_1 brown for their entire length.

Abdomen fairly broad, dull brownish-yellow, with an irregular median longitudinal slate-grey stripe. Dorsum covered with sparse coarse short black hairs; base of second segment with a transverse row of finer longer creamy hairs; side margins with mixed black and creamy hairs, which do not form the conspicuous fringe in the male usually seen in this sex. Venter greyish-white, with very sparse and fine silky white hairs. Genitalia not unlike *T. costalis* Westw., but the median lobe at the distal end of the ninth tergite is smaller and more pointed.

Length: ♂, body 18 mm., wing 17 mm.; ♀, with ovipositor extended, 21 mm.

Holotype ♂ from Russell Island, December, 1921; allotype ♀ from Stradbroke Island, 3rd December, 1912, both in the Queensland Museum.

This species bears a close superficial resemblance to *T. bancrofti*, nov., from which it is easily separated by the subgroup characters. In other respects it is somewhat intermediate between the *costalis* and the *punctata* series, but the relatively stout palpi and general dullness of the coloration indicate closer affinities with the former.

Trichophthalma punctata Macquart.

Hirmoneura punctata Macquart, 1846.—*H. nigriventris* Macquart, 1850.—*H. novae-hollandiae* Macquart, 1850 *nec* 1846.—*Trichophthalma novae-hollandiae* Macq., White, 1914.—*T. quadricolor* Walker, 1849.

Macquart, 1846, p. 101; 1850, p. 98, Pl. ix, fig. 9, and p. 99.—Walker, 1849, p. 234.—Lichtwardt, 1910*a*, pp. 376 and 380.—White, 1914, p. 65, fig. 9.—Hardy, 1924, p. 452.

"Fusca cinereo-tomentosa. Abdomine nigro punctata; lateribus rufis. Pedibus rufis.

"Long de 5, 6 ♂ l. Trompe menue, long de 1½ l., à lèvres assez épaisses. Palpes jaunes, à extrémité brune. Barbe blanche. Face fauve à léger duvet jaunâtre. Front à duvet blanc. Antennes noires; premier article brunâtre; troisième conique. Yeux velus. Thorax brun, à duvet grisâtre et poils fauves. Abdomen à duvet gris, côtés fauves et taches ou bandes dorsales noires; ventre et poitrine à duvet blanc. Cuisses à poils blancs. Ailes assez claires; base et bord extérieur bruns; nervures comme dans l'H. Novae Hollandiae. De la Tasmanie. Muséum."

A variable species both in size and colour, the size varying from large-medium stout to small slender specimens, and the colour of the abdomen from rich orange to dull drab in the male, female always dark and rather slender. Thorax with two indistinct paler longitudinal lines on a brown ground. Abdomen with a characteristic median line of small black spots. Wings with fore-borders brown. There are two subspecies and one variety.

♂. Eyes dark reddish-brown, almost meeting below ocelli, hairs brown above, creamy-white below. Frons greyish-yellow to yellowish-brown, with a line of fine creamy hairs on each side of an inconspicuous keel; face same colour, with sparse hairs, creamy in pale, black in dark specimens; beard short, creamy-white. Basal segments of antenna with creamy-yellow bloom and creamy hairs, third segment and style black. Proboscis one-half longer than the head, of moderate thickness and with prominent labellae; palpi brown, black at tip, with coarse short black hairs.

Thorax dull brown with an indistinct paler brown stripe on each side of the mid-line, these stripes becoming confluent in front of the scutellum which is the same colour as the stripes. Dorsum with rather long fine brown hairs; side margins with dense long creamy hairs mixed with some grey ones; postalar tuft similar; scutellum with almost entirely orange hairs at the edge. Pleurae pale grey with long silky creamy-white hairs. Legs yellowish-brown, dark brown dorsally on tarsi, hind tibia and tarsus dark brown, almost black dorsally on tarsi. Wings clear to somewhat smoky, brown along fore border.

Abdomen orange with a drab central stripe surrounding the small black median spot on each segment. This drab colour extends for a variable extent, in many Tasmanian specimens completely covering the abdomen and eliminating the orange altogether. Dorsum with rather long and fine orange to brown hairs, base of second segment with a transverse zone of silky orange to creamy hairs; side margins with long dense creamy-yellow to orange hairs, sometimes tipped with black. Venter pale grey, with short, rather scanty, silky white hairs. Genitalia as in Text-fig. 6, *a* and *b*.

♀. Frons and face paler than in the male, beard pure white. Thorax not usually quite such a dark brown. The main difference is in the abdomen, which is rather slender and of a uniform drab colour, never showing any trace of orange and consequently never having any darker patches surrounding the black median spots.

Length as under the subspecies.

Distribution.—Tasmania, Victoria, South Australia, New South Wales, Queensland.

This species is to be distinguished by the indistinctly marked thorax, by the small abdominal spots not forming a continuous stripe, and by the variable

amount of drab coloration and the absence of lateral dark markings on the abdomen. The orange of the abdomen is much duller than in *T. fulva* Walk. and the lateral hairs are different. Two subspecies and a variety may be recognized in the male. The distribution of the subspecies is different, though there may be a little mixing now at the point of contact.

(1) T. PUNCTATA PUNCTATA Macq.—The most variable; abdomen darker orange than in the next form and with the drab colour more extensive, often covering the whole abdomen. In general, as White (1914) observed, the larger specimens are broader and predominantly orange, while the smaller are more slender and entirely drab, except for the median black spots. Fore border of wing strongly brown. Distostyle as in Text-fig. 6, *a*.

Length: 14 to 10 mm. (one Tasmanian female measured 16 mm.).

Distribution.—Tasmania: Hobart, Launceston, St. Helens, Wynyard, St. Marys, Swansea, Devonport. Hardy also gives South Bruni Island, Wedge Bay, Dunally and Mt. Maria. The dates range from the 27th December to the 18th March, the great majority being taken taken in January. Victoria: Ringwood, Box Hill, Belgrave, Gippsland. Dates September and February. South Australia: a male and female without further data in the South Australian Museum. New South Wales: Wee Jasper, near Yass, February, 1920. This subspecies has developed in Tasmania and reinvaded the mainland, where it is interesting to note that, at any rate in Victoria, it can apparently maintain its identity alongside the other subspecies.

(2) T. PUNCTATA ORIENTALIS, n. subsp.—A stout variety; abdomen with the drab colour restricted to a median band surrounding the black spots and only overflowing to a small extent posteriorly in a few specimens. Fore border of wing only faintly brown. Distostyle as in Text-fig. 6, *b*. There are linking forms in the typical subspecies in coloration, but the genitalic differences are constant over a considerable series in both subspecies.

Length 15 to 12 mm.; the smaller specimens are as stout as the larger, not slenderer as in the typical subspecies, so the differences in size are not so obvious.

Distribution.—Victoria: Dandenong Ranges, no date, 2 males and 1 female. New South Wales: Barrington Tops, Mittagong, Wentworth Falls, Berowra, Toronto, Cordeaux Dam, Sydney. The dates range from the 6th December to early February. Queensland: Brisbane, 27th October, and Endeavour River. The home of this subspecies appears to be in eastern New South Wales.

Holotype ♂ and allotype ♀, both from Barrington Tops, in the Macleay Museum.

(3) T. PUNCTATA var. MINIMA, n. var.—A male and female before me differ from those described above in being very small and slender, and with the abdomen so dark that the black spots are indistinct. Wings with hardly a trace of brown. Genitalia as in *T. punctata orientalis*, nov., in company with which the male occurred at Barrington Tops. In general, this variety is like a very small Tasmanian type with the genitalia of the eastern mainland form.

Length: ♂, 8 mm., ♀, 9 mm. (the smallest Tasmanian ♂ was 10 mm. and ♀ 11 mm.).

Holotype ♂, Barrington Tops, early February, 1924, in the Macleay Museum; allotype ♀, Russell Island, December, in the Queensland Museum.

The males are usually taken hovering, but have been found feeding in company with the females on *Leptospermum* sp. White records the female feeding on the Flowering Box and resting on young wattles in Tasmania, where

this species seems to be commoner than anywhere else and is found as abundantly at sea-level as in the mountains. The distribution of the typical subspecies on the mainland is, in general, west of the Divide, that of subsp. *orientalis*, nov., on the mountains and to the east of them. The latter is much commoner on the mountains, being quite a rarity on the coast.

With regard to the synonymy, Macquart described *T. novae-hollandiae* three times, the last of these, from Tasmania, being clearly this species. White followed him in naming the Tasmanian species *T. novae-hollandiae* Macq. The other names, also proposed for Tasmanian specimens, clearly belong here. Lichtwardt considered *T. fulva* Walk. to be a synonym of *T. punctata* Macq.; he is possibly right, but on present evidence they must be considered as distinct. Hardy refers all mainland specimens of this species to *T. fulva* Walk., under which name he has placed several distinct species.

TRICHOPHTHALMA FULVA Walker.

Walker, 1849, p. 235.—Lichtwardt, 1910*a*, p. 380, in part.—Hardy, 1924, p. 452, ? in part.

"Mas. Fusca subtus alba, thorace vittis duabus scutelloque lividis, abdomine fulvo-fusco, univittato, antennis fulvis apice nigris, pedibus ferrugineis, femoribus fulvis, alis subcinereis, ad costam subfuscus.

"Body white beneath; head clothed with white hairs above the insertion of the feelers, and more thickly covered beneath with pale yellow hairs; hypostoma tawny, and clothed with yellow hairs; eyes red, thickly clothed with white or tawny down; mouth black, a little shorter than the chest; palpi tawny, piceous at the tip; feelers tawny; third joint short-conical; bristle black, much longer than all the preceding joints; breast thickly clothed with white hairs; chest rich brown, with two livid stripes, and adorned with a fringe of golden hairs on each side and behind; scutcheon also livid; abdomen tawny, clothed with golden hairs, which form a fringe on each side; the broad dark brown stripe on the back is somewhat dilated on the sutures of the segments; legs ferruginous; hips and thighs tawny; wings slightly grey; fore borders till near their tips pale brown, which colour blends with the grey on the disks; wing-ribs and veins dark ferruginous; the other veins piceous; poisers tawny. Length of the body 4-5½ lines; of the wings 9-12 lines. West Australia."

A rather small stout species with dark brown thorax on which are two prominent fairly broad pale lines. Abdomen bright orange with a narrow median black stripe. Wings clear, brownish on fore border.

♂. Eyes rich dark brown, not quite meeting below ocelli, with long bright hairs above, creamy below. Frons and upper part of face creamy-white, with scanty pale creamy hairs; lower part of face a pale yellowish-brown; beard white. Basal segments of antenna creamy-yellow with short fine creamy hairs, third segment and style black. Proboscis about one-third longer than the head, slender and with small labellae; palpi bright brown, black at tip.

Thorax dark brown, with two pale greyish-brown fairly broad stripes which are about the same width as the brown median part; scutellum not so dark as the ground colour of the scutum. Dorsal hairs very fine, brown; lateral, postalar and scutellar hairs long and dense, rich orange in colour, here and there tipped with dark grey. Pleurae pale grey with white and creamy hairs. Legs entirely bright yellowish-brown. Wings fairly clear, rather broadly infuscated with bright brown along the fore border.

Abdomen bright orange, with a narrow median longitudinal black stripe which is somewhat widened in the middle of the segments. Dorsal hairs scanty, fine and silky, yellow; side with long bright yellowish-orange hairs; on the dorsum, towards the lateral edges of the second segment, is a large patch of rich orange hairs, and a similar one on the third segment. These patches are continuous with the lateral hairs and form a conspicuous feature of this species. Venter pale yellowish-grey with scanty silky creamy hairs. Genitalia as in Text-fig. 6, *c*.

Length: ♂, body 11 mm., wing 11 mm.

This description is based on three males in the Australian Museum, one from King George's Sound, Western Australia, the other two labelled Queensland and without any further data. More material and the discovery of the female are highly desirable in order to test the validity of this species, which may be recognized by the combination of well marked stripes on the thorax with the bright orange abdomen with a narrow black stripe and bright orange hair patches at the sides of the second and third segments.

There is little doubt that this is the true *T. fulva* Walk., his description being based on a Western Australian specimen and agreeing very well with those before me. The brief notes on the abdomen given in White's key (Hardy, 1924, p. 447) also fit this species, rather than any of the others which have gone under the name. For further remarks see under *punctata* Macq. and *confusa*, nov.

A single male before me, the locality and date of which are indecipherable, is very close to this species, but differs in the following respects: frons yellowish-brown with pale gold hairs, face rather dark brown with black hairs, beard creamy-yellow, palpi greyish-black. Proboscis moderately stout, with large, prominent labellae. Thoracic lines narrow and rather widely separated. Hind tibia and tarsus much darker than fore and mid. Wings clear, very faintly brown anteriorly. Genitalia as in *T. punctata punctata* Macq. Without further material it would be unwise to say more about it, but it may prove to be a distinct species.

Trichophthalma confusa, n. sp.

Lichtwardt, 1910*a*, p. 380, in part.—Hardy, 1924, p. 452, in part.

A small-medium sized fairly slender species, with brown thorax on which are two fairly broad pale stripes. Abdomen brownish-yellow in male, drab in female, with a rather narrow median black stripe and black side margins. Legs bright brown, hind tibia and tarsus dark brown. Wings smoky, brown along fore border.

♂. Eyes brown, distinctly separated, with brown hairs above, white below. Frons with creamy bloom and narrow black keel, hairs scanty, very fine, creamy; face brownish-grey, with creamy-yellow hairs; beard creamy-white, short and inconspicuous. Basal segment of antenna pale yellowish-brown, second segment brown, both with creamy-yellow hairs, third segment and style brownish-black. Proboscis about one-half longer than the head, of moderate thickness, and with prominent labellae; palpi brown, with creamy hairs basally, black towards the apex which is black.

Thorax like that of *T. fulva* Walk. with the same colours and the same width of stripes. Lateral, postalar and scutellar hairs a much duller, more creamy yellow. Pleurae pale grey with patches of silky white hairs. Legs pale yellowish-brown, last tarsal segment of fore and mid legs dark brown dorsally,

hind tibia and tarsus dark brown, almost black dorsally on distal tarsals. Wings somewhat smoky, deep brown along the fore border.

Abdomen rather long and narrow, bright brownish-yellow, with a black median stripe which is widened in the middle of the segments, and with prominent black side margins, wider on the anterior segments. Dorsal hairs pale yellow, silky; rather longer and less sparsely arranged at the base of the second segment; lateral hairs dense but not long, dull yellow tipped with creamy. Venter very pale yellowish-grey, with scanty fine silky white hairs. Genitalia as in Text-fig. 6, *d*.

♀. Slenderer in body than male. Ground colour of abdomen dull drab, similar to that of *T. punctata* Macq.; lateral hairs of abdomen less conspicuous than in male.

Length: Both sexes, body 13 mm., wing 13 mm. A very small male from Berowra and another from Kendall measure only 7 mm., but differ in no other respect from the usual form, in company with which they occurred.

Distribution.—New South Wales: Kendall, Berowra, Heathcote, National Park, Roseville, Como. The season is November and December, and specimens have been taken feeding on the flowers of *Angophora* sp. and *Kunzia* sp. Victoria: Bright, no date.

Holotype ♂ and allotype ♀ from Berowra, 11th December, 1923, in the Macleay Museum.

This species is easily separated from its allies by the presence of prominent lateral dark stripes on the abdomen. It is not uncommon in the coastal districts of New South Wales, and is the species usually identified as *T. fulva* Walk., the error apparently having arisen through a misidentification of one of Dr. Ferguson's specimens by White. Most of the specimens determined as *T. fulva* Walk. by Hardy belong here, and it is to this species that his notes apply best. The Queensland specimen mentioned by Lichtwardt as *T. punctata* Macq. is probably this species. The three species mentioned above form a closely related group, which has caused considerable confusion and difficulty in the past. One must wait for further material and the judgment of those who have access to the types in order to test the suggestions made here.

Trichophthalma ruficosta, n. sp.

A medium-sized fairly stout bodied species, with uniformly dark grey thorax and greyish-brown abdomen with a fairly narrow dark brown median stripe and dark sublateral stripes. Legs pale brown. Wings with costal region broadly bright brown.

♂. Eyes brown, distinctly separated below ocelli; hairs brown above, creamy below. Frons with greyish-white bloom and sparse fine pure white hairs, keel short and narrow, black; face brown, shining, with some bloom and with pale yellow hairs; beard creamy-white. Basal segment of antenna bright pale yellow, second brown on medial aspect, yellow on lateral, both with short creamy-yellow hairs; third segment and style brownish-black. Proboscis one-half longer than the head, fairly stout, with prominent labellae; palpi bright yellowish-brown, black at tip, with short creamy-yellow hairs.

Scutum and scutellum blackish-grey (apparently not at all greasy), with brown hairs. Sides with dense creamy hairs mixed with some grey ones; postalar region and margin of scutellum with creamy-yellow hairs. Pleurae rather dark grey, with patches of creamy and white hairs. Legs bright yellowish-brown,

hind tibia and tarsus somewhat darker. Wings slightly smoky, broadly bright brown anteriorly.

Abdomen broad, fawn coloured, with a narrow blackish-brown median stripe, which has the appearance of linked spots. Sides of second, third and fourth segments with a well marked dark brown longitudinal band which is sublateral in position, there being a zone of rather pale fawn colour lateral to the band. Hairs brown and creamy-yellow, longer and brighter yellow at base of the second segment. Marginal hairs but little differentiated, same colour as those on dorsum. Venter greyish-white, with scanty silky white hairs. Genitalia as in *T. confusa*, nov.

Length: ♂, body 15 mm., wing 14 mm.

Holotype ♂ and one other ♂ from King George's Sound, Western Australia, no date, in the Australian Museum.

This species is nearest to *T. confusa*, nov., but is separated by the unadorned thorax and by the different abdomen.

Trichophthalma bivitta bivitta Walker.

Walker, 1857, p. 135.—Lichtwardt, 1910*a*, p. 381.—Hardy, 1924, p. 454.

"Nigricante fusca, albo-pilosa, subtus alba, capite albo, antennis nigris basi albis, thoracis lateribus testaceo-pilosis, abdomine vittis duabus latis pallide luteis, pedibus fulvis, alis cinereis apud costam fuscis, venis nigris, halteribus testaceis.

"Blackish brown, narrow, with white hairs, underside with white tomentum; head white, proboscis and antennae black, the latter white at the base; thorax with testaceous hairs along each side; abdomen with a broad pale testaceous stripe on each side; legs tawny; wings grey, brown along the costa, veins black, halteres testaceous. Length of the body four lines; of the wings 8 lines. Australia."

I propose to divide Walker's species into two, separating the mountain top form under a different subspecific name.

A small slender species with velvety-black thorax edged with striking yellow hairs; abdomen brownish-yellow in male, yellowish-brown in female, with a fairly broad black median stripe and narrowly black side margins, and with, occasionally, narrow black transverse bands at the apices of the segments. Legs brown, hind tibia and tarsus dark brown. Wings slightly smoky, with brown fore border.

♂. Eyes reddish-brown, just touching a little below ocelli, hairs brown above, creamy below. Frons yellowish-grey, with a narrow black keel on its upper part, with very fine white-tipped creamy hairs; face a little darker than the frons, brown round oral margin, with sparse creamy-yellow hairs below; beard pure white. Basal segments of antenna black, covered for the most part with greyish-yellow bloom, hairs creamy-yellow; third segment and style brownish-black. Proboscis one-half longer than the head, rather slender and with prominent labellae; palpi dark brown, with black hairs.

Scutum velvety-black, covered with sparse long silky golden hairs, which are rather denser in the middle, especially in front of the scutellum which is dark brown in colour. Lateral margin, postalar region and margin of scutellum with long dense dull golden-yellow hairs, forming a conspicuous zone round the thorax. Pleurae pale grey, with a dense patch of long pure white hairs anteriorly, more scattered yellow to creamy ones below wing-root, and a few long white hairs elsewhere. Legs pale yellowish-brown, last tarsal segment on fore and mid legs

dark brown dorsally, hind tibia and tarsi dark brown, especially dorsally. Wings somewhat smoky, pale brown along the fore border.

Abdomen yellow with a tinge of brown, with a broad black median stripe occupying a little less than one-third of the width of the abdomen and somewhat expanded at the apices of the segments; sides of second, third and part of fourth segments black, rather broadly so on second segment; apical edges of the segments sometimes with a narrow black transverse band. Dorsal hairs fine, pale gold, denser at base of the second segment; lateral hairs long, pale gold, rather dense on second and base of third segments, scanty further back. Venter pale yellowish-grey, with scanty fine white hairs. Genitalia as in Text-fig. 6, *e*.

♀. Differs from the male in the lateral hairs to the thorax, which are creamy rather than gold, and in the abdomen, the ground colour of which is yellowish-brown, though not the dull drab colour of *T. confusa*, nov. and its allies. The hairs on the abdomen are scanty and creamy in colour.

Length: ♂, body 10 mm., wing 9 mm. The ♀ is longer and may measure up to 13 mm.

Distribution.—Queensland: Brisbane, Stradbroke Island, Russell Island. Dates October and December. New South Wales: Merriwa, Gunnedah, Manly. All taken in November. Victoria: Bacchus Marsh, no date. There is no record of its occurrence anywhere on the mountains.

The character of the thorax separates this subspecies from all but *T. bivitta nigricosta*, nov. and *T. harrisoni*, nov. From the former it differs in its smaller size, in the paler wings, and in the slightly narrower median abdominal stripe. From the latter it is only to be separated safely by the genitalia of the male, but the median abdominal stripe is wider and the transverse black bands, if present, are not so prominent.

This is clearly Walker's species and the determination is confirmed by the characters given in White's key (Hardy, 1924). In this key the names *bivitta* Walk. and *bivittata* Westw. have obviously been interchanged and this error, together with a misidentification by White based on it, led Hardy to query *bivitta* Walk. as a synonym of *rosea* Macq. Lichtwardt included more than one species in his conception of *bivitta* Walk. This subspecies has sometimes been identified as *T. fulva* Walk.

Trichophthalma bivitta nigricosta, n. subsp.

Differs from *T. bivitta bivitta* Walk. in its larger size, in the duller ground colour of the abdomen, which does not differ in the sexes, in the distinctly broader black median band and almost entire absence of transverse bands (faintly indicated in one specimen only), and in the much darker brown, almost black colour of the anterior part of the wings. Genitalia similar.

Length: ♂, body 13 mm., wing 12 mm. ♀, 14 mm.

Distribution.—New South Wales: Barrington Tops, early February, 1925, 4 ♂♂ and 10 ♀♀, feeding on *Leptospermum* sp.

Holotype ♂ and allotype ♀ in the Macleay Museum.

This is probably the mountain form of *T. bivitta* Walk., but may possibly be a distinct species. When two forms are restricted in range, the one to the coast and the other to the mountain tops, one is, I think, just as justified in making subspecies of them as under any other conditions.

TRICHOPHTHALMA HARRISONI, n. sp.

A small species, stouter-bodied than *T. bivitta* Walk.; thorax like *T. bivitta* Walk. Abdomen brownish-orange in the ♂, yellowish-brown in the ♀, with a narrow median black stripe, narrowly black side margins and black basal and apical edges to the segments. Legs bright brown, hind tibia and tarsus darker. Wings smoky with slightly darker fore border.

♂. Eyes reddish-brown, almost meeting below ocelli, hairs dark brown to pitchy above, creamy below. Frons greyish-yellow, with an inconspicuous keel on the upper part and with short creamy hairs; face a little darker, with longer, stouter pale gold and black hairs; beard creamy-white. Basal segments greyish-black with greyish-white bloom and creamy hairs, third segment and style greyish-black. Proboscis one-half longer than the head, fairly slender and with prominent labellae; palpi dark brown, with rather short black hairs.

Thorax and legs like *T. bivitta* Walk. Wings smoky, slightly darker in cells Sc and R_1, the colour not being so conspicuous as in *T. bivitta* Walk.

Abdomen dull brownish-orange, with a narrow black median band, which is widened in the middle of the segments so as to give the appearance of coalesced spots, with very narrowly black side margins, and with black transverse bands at the bases and apices of the segments, the combined adjacent bands forming a conspicuous feature of the abdomen. Dorsum with long dark grey hairs and scattered short silky pale gold ones, the latter being longer and denser and forming a transverse zone at the base of the second segment. Sides with long pale creamy-yellow hairs mixed with grey ones, the creamy hairs are paler, longer and denser at the base of the second segment. Venter pale yellowish-grey, with scanty silky white hairs. Genitalia as in Text-fig. 6, *f*; the resemblance to *T. punctata orientalis*, nov., and the difference from *T. bivitta* Walk. are very striking.

♀. Differs from the ♂ in its somewhat slenderer form, in the yellowish-brown colour of the abdomen, less conspicuous black transverse markings, and in the scantier less conspicuous hairs.

Length: ♂, body 10 mm., wing 9 mm.; ♀, 12 mm.

Distribution.—Barrington Tops, early February, 1925, 7 ♂♂ and 5 ♀♀, some feeding on *Leptospermum*, some hovering under a snow-gum; also 1 ♂, same locality, 25th January, 1923, coll. Nicholson.

Named in honour of Professor Harrison, who led the expedition and who captured the first specimens.

Holotype ♂ and allotype ♀ in the Macleay Museum.

At first sight this species seems to resemble *T. bivitta bivitta* Walk. more closely than does *T. bivitta nigricosta*, nov., but a closer investigation shows that the differences are more marked than they appeared at first. It may be separated from both by the genitalia of the male, by the paler anterior margin of the wing, rather stouter habit and by the much narrower median and lateral and more marked transverse markings on the abdomen.

TRICHOPHTHALMA NICHOLSONI, n. sp.

A medium-sized species of moderate habit. Thorax dark brown with pale sides, two well defined pale lines and an indistinct median one. Abdomen pale fawn, with a broad black central stripe and black side margins. Legs brown. Wings with fore border brown.

♂, ♀. Eyes dark brown, almost meeting below ocelli in ♂, hair dark brown above, creamy below. Frons covered with brownish-yellow bloom, keel indistinct, hair sparse and short, creamy; face similar, hairs rather longer; beard rather longer than usual in this series, creamy-white. Basal segments of antenna pale yellowish-brown, with creamy hairs, base of third segment brown, remainder and style black. Proboscis about one-third longer than the head, fairly stout and with prominent labellae; palpi light brown with dark brown hairs.

Thorax dark brown with yellowish-grey side margins forming a pale band above wing-root, with two narrow well defined yellow-brown longitudinal lines, which double their width behind the transverse suture, and with a very indistinct broader median yellowish-brown line. The two lateral lines are separated by quite four times their breadth. Scutellum brown, not so dark as scutum. Dorsal hairs brown, silky; side margins, postalar region and edge of scutellum with long dense creamy hairs. Pleurae pale grey with patches of long creamy-white hairs. Legs bright brown, darker dorsally on tarsi, hind legs a little darker than fore and mid. Wings faintly smoky, dark brown on fore border, the darkening being rather broad in the middle of the wing length, but fading rapidly apically.

Abdomen broad, pale fawn, with a broad median dark stripe, which has perfectly straight edges and which occupies about one-third of the width of the abdomen. Sides of second, third and fourth segments with conspicuous dark stripes. Dorsal hairs bright brown and creamy, longer at base of second segment; marginal hairs creamy, rather dense but short, except at base of second segment, where they are fairly long. Venter greyish-white with scanty white silky hairs. Male genitalia as in Text-fig. 6, *g*.

Length: ♂, ♀, body 14 mm., wing 14 mm.

Distribution.—New South Wales: Kosciusko, 11th February, 1924, 2 ♂♂, 1 ♀, coll. Nicholson.

Holotype ♂ and allotype ♀ in the Macleay Museum.

This species and its allies may be readily separated from the rest of the series by the two narrow well-defined widely separated pale lines on the thorax and by the ninth tergite of the male. The discrimination of these species from one another is a matter of some difficulty; *T. trilinealis*, nov., is definitely distinct, since it was collected at the same time in the same situation, and differs more than the limits of variation found in the genus. It may be separated by the black sides of the scutum, the better defined median pale line, different abdominal markings, clearer wings and smaller size. *T. dubiosa*, nov., presents a more difficult problem. Though not yet taken at Kosciusko, it is a highland species and its distribution overlaps that of *T. nicholsoni*, nov. The thorax is similar, but the wings have hardly a trace of brown and the abdomen is much darker, with a narrow median dark stripe and only very small inconspicuous dark zone at the side margins. *T. griseolineata*, nov., is close, but is much smaller, and differs both in thoracic and abdominal markings. It may be the South Australian representative of one of these species. The genitalia do not help here, being practically identical in all.

Trichophthalma trilinealis, n. sp.

A small fairly slender species with black thorax on which are three narrow pale lines. Abdomen brownish-yellow, with a black median stripe, very narrowly

black side margins and apices to the segments. Legs brown. Wings smoky, not darkened on fore border.

♀. Eyes dark brown, with dark brown hairs above, creamy below. Frons with creamy bloom and short sparse creamy hairs below and five or six short brown ones just below ocelli, no keel; face with creamy bloom in middle, brown at sides, with longer, more abundant black hairs; beard creamy-white. Basal segments of antenna yellowish-grey, with creamy hairs and some black ones at apex of second segment, third segment and style brownish-black. Proboscis black, nearly twice the head length, fairly slender and with prominent labellae; palpi dark brown, with strong black hairs.

Thorax blackish-brown with a very faint indication of paler colour at sides and with three narrow well defined brown longitudinal lines; scutellum dark brown. Dorsal hairs brown; lateral, postalar and scutellar hairs creamy-white mixed with dark grey. Pleurae pale grey, with patches of long white hairs. Legs brown, darker dorsally on tarsi, hind tibia and tarsus slightly darker. Wings somewhat smoky, very faintly tinged with brown in cells Sc, R and R_1.

Abdomen dull fawn, with a black median stripe, rather less than one-half the width of the segments and widened a little at the apex of each segment. Sides of all segments narrowly black, widened on posterior part of second and third segments. Posterior edge of each segment with a very narrow black transverse band. The attenuated terminal segments are predominantly black. Dorsal hairs brown; lateral hairs creamy, with patches of black apically on second and third segments. Venter greyish-white, with scanty silky greyish-white hairs.

Length: body 14 mm., wing 13 mm.

Holotype, the unique female from Kosciusko, 11th February, 1924, coll. Nicholson.

For further remarks see under *T. nicholsoni*, nov.

TRICHOPHTHALMA DUBIOSA, n. sp.

A small to medium sized moderately stout species. Thorax blackish-brown with two well defined pale lines. Abdomen yellowish-brown with a narrow black median stripe and a little black at the sides of the second and third segments. Legs brown, hind tibia and tarsus very dark. Wings with hardly a trace of brown anteriorly.

♂, ♀. Eyes dark reddish-brown, a little separated in the ♂, closest just below ocelli, hairs dark brown above, white at extreme lower edge. Frons bright yellow-brown with black keel, scanty pale yellow hairs below and a patch of short strong black hairs below ocelli in the female; face brown, with rather strong black hairs; beard white, yellowish anteriorly. Antenna with basal segment light brown with gold hairs, second dark brown with black hairs, third segment and style black. Proboscis about one-third longer than the head, fairly slender and with prominent labellae; palpi brown, with strong black hairs.

Thorax blackish-brown, with dull fawn sides forming a band just above wing-root. There are two well separated, narrow, dull yellowish-brown lines and occasionally faint traces of a median line. Scutellum dull brown. Dorsum with brown hairs; side margins with dull creamy-yellow hairs mixed with grey ones; postalar region and margin of scutellum with dull gold hairs. Pleurae grey with patches of white hairs and a few yellowish ones. Legs brown,

darker dorsally on tarsi, hind tibia and tarsus almost black. Wings somewhat smoky, with a faint trace of brown anteriorly.

Abdomen fairly broad, dull yellowish-brown, with a narrow black median stripe, less than one-third the total width of the abdomen, and narrow black margins to second and third segments. Dorsum with dull gold and black hairs, the latter on the black parts, base of second segment with longer dull gold hairs; lateral hairs thick in the male, hardly differentiated in the female, dull gold in colour, tipped with dark grey in parts. Venter as in the related species. Genitalia similar, but inner salience of distostyle slightly but definitely less developed.

Length: ♂, body 11 mm., wing 11 mm. The largest ♀ measured 14 mm.

Distribution.—New South Wales: Meldrum (Dorrigo), 23rd December, 1917; Barrington Tops, early February, 1925. Victoria: no further data, a ♂ in the National Museum.

Holotype ♂ and allotype ♀, both from Meldrum, in the Macleay Museum.

The Barrington Tops females are larger and more strikingly marked than the others, but are little different in other respects. For further notes see under *T. nicholsoni*, nov.

TRICHOPHTHALMA GRISEOLINEATA, n. sp.

A small species. Thorax dark brown with two prominent slate-grey lines. Abdomen dull to yellowish-grey, with dark brown median stripe and brown sides and apex to the second and third segments. Wings brown at fore border. Legs bright brown.

♂, ♀. Eyes reddish-brown, almost meeting below ocelli in male, with brown hairs above, creamy ones round lower margin. Frons and face pale grey, with white hairs; beard white, creamy posteriorly. Basal segments of antenna pale yellow, with white hairs, third segment and style brownish-black. Proboscis nearly twice as long as head, rather slender and with fairly large but not very prominent labellae; palpi bright yellowish-brown, black at tip.

Thorax black, with sides very narrowly grey. The two fairly narrow dull grey lines are widely separated anteriorly and converge markedly towards the scutellum, which is brownish-black. Dorsum with scanty pale yellow hairs; side margins and margin of scutellum with dull creamy-yellow hairs, more whitish in female, mixed with dark grey ones; postalar tuft bright pale yellow. Pleurae grey, with patches of creamy hairs and a patch of pale yellow ones below wing-root. Legs bright yellowish-brown, hind tibia and tarsus slightly darker. Wings smoky, faintly but definitely brown along fore border.

Abdomen fairly slender, dull grey to yellowish-grey, with a dark brown median stripe, which is expanded towards the apices of the segments and which is nearly one-third of the width of the abdomen. Sides and apex of second and third segments dark brown. Dorsum with brown to dull yellow hairs, longer at base of second segment; side margins with creamy-yellow hairs, alternating with patches of black ones on second and third segments. The hairs are hardly differentiated in the female. Venter pale creamy with sparse silky white hairs. Male genitalia similar to *T. nicholsoni*, nov.

Length: both sexes, body 11 mm., wing 11 mm.

Holotype ♂ and allotype ♀ from South Australia, without further data, in the Australian Museum.

For further remarks see under *T. nicholsoni*, nov.

TRICHOPHTHALMA LEUCOPHAEA Walker.

Trichophthalma degener Walker, 1849.—*T. heydenii* Hardy, 1924, *nec* Jaennicke, 1867.—*T. leucophaea* Walker, 1849, *nec* Hardy, 1924.

Walker, 1849, p. 233.—Lichtwardt, 1910*a*, p. 379.—Hardy, 1924, pp. 453, 454.

"Fusca, subtus alba, thorace fulvo univittato et albo bivittato, scutello utrinque albo, abdomine albo bivittato, antennis fulvis, pedibus ferrugineis, tarsis piceis, alis cinereis, ad costam fuscis.

"Body rich brown, white underneath: head white, thickly clothed beneath with white hairs; eyes piceous, thickly clothed with white down: sucker black, as long as the chest: feelers, hypostoma, and palpi tawny; the latter piceous at the tip: chest with a very slender tawny stripe in the middle, and two broader white stripes on each side; the inner white stripes are somewhat widened in the middle, whence two oblique bands of tawny hairs pass from them to the outer stripes, and join a fringe of the same colour on each side of the chest: a white semicircular band on each side of the scutcheon: breast thickly clothed with white hairs: abdomen with two white stripes, which are somewhat irregular in outline, and slightly widened on the fore borders of the segments: legs ferruginous, clothed with black hairs; thighs also clothed with white hairs; feet piceous; wings gray, slightly brown in front on half the breadth and two-thirds of the length, whence to the tips the fore borders only are brown; wing-ribs and fore border veins ferruginous; the other veins black; poisers tawny. Length of the body 6 lines; of the wings 14 lines. Western Australia."

A medium sized species with very long proboscis. Thorax with two narrow pale lines. Abdomen brown at sides, broadly dark brown in the middle, intermediate part greyish-creamy colour.

♂, ♀. Eyes dark brown, separated as much in the ♂ as is usual in the ♀ of this genus, ♀ eyes a little more widely separated, hairs brown above, white below and at sides. Frons and face covered with greyish-white bloom, pale brownish in lower part of face, hairs white, sparse and short; beard long, pure white. Basal segments of antenna greyish-brown with creamy hairs, third segment and style black. Proboscis three times the head length, fairly slender and with small inconspicuous labellae; palpi brown, with short black hairs, apically very thin, black.

Thorax rich dark brown, with greyish-white side margins forming a band above the wing-root, and with two fairly narrow stripes of the same colour, which are widened at the transverse suture and which are well separated anteriorly but converge somewhat towards the scutellum, just in front of which they broaden out medially and meet. Scutellum brown, with a crescentic grey band, which may be absent, at the posterior margin. Dorsal hairs brown and black; side margins with dense woolly dull pale yellow hairs mixed with longer stouter black ones; postalar tuft partly creamy-yellow, partly black; margin of scutellum with dull yellow hairs and some black ones. Pleurae pale grey, with tufts of long white hairs. Legs brown, hind tibia and tarsus dark brown. Wings faintly smoky, fairly broadly brown along fore border.

Abdomen broad in ♂, fairly slender in ♀, with a broad dark brown median stripe, slightly widened at the apices of the segments. Side margins with an almost equally broad paler brown stripe, these bands being also broader at the apices of the segments. The difference in colour between the medial and lateral stripes is more marked in the male than in the female. Intervening parts forming an irregular greyish-white stripe on each side, this stripe being definitely

narrower than the brown ones. All the stripes narrow towards the apex of the abdomen, the lateral ones fading out on the fifth or sixth segments. Dorsum with black and yellow hairs, base of second segment with creamy hairs, longer and yellowish towards the sides; side margins with short dense creamy hairs. Venter pale creamy-grey, with short silky white hairs. Genitalia as in Text-fig. 6, *h*, not unlike *T. confusa*, nov.

Length: both sexes, body 14 mm., wing 13 mm.

Distribution.—Western Australia: Perth, Swan River, Nedlands River, King George's Sound. Season, November.

This species is separated from all but *T. longirostris*, nov., by the very long proboscis and inconspicuous labellae. From the latter it is separated by the thoracic and abdominal markings. There is a pair in the Australian Museum which are rather larger than usual and have the thoracic and abdominal markings a little wider, but do not differ in any other respect. I cannot separate *leucophaea* Walk. from *degener* Walk., which was described immediately after it. The species before me fits both fairly well, but agrees perhaps a little better with the latter. The tawny hairs joining the thoracic stripes referred to by Walker are present in all, but are never very prominent. This species is the one recognized as *degener* Walk. and also as *heydenii* Jeann. by Hardy (1924), but not the one he indicates as *leucophaea* Walk. As mentioned before, this species bears an extraordinarily close resemblance to that described from Chili by Jaennicke as *Hirmoneura nemestrinoides*, certainly close enough to throw grave doubts on their generic distinctness.

TRICHOPHTHALMA LONGIROSTRIS, n. sp.

Trichophthalma leucophaea Hardy, 1924, p. 454, *nec* Walker, 1849.

A medium sized fairly stout species with a very long proboscis. Thorax with two moderately broad pale lines. Abdomen brown at sides, with a narrow black median stripe and broader pale intermediate stripes.

♀. Eyes dark brown, separated as much as in *T. leucophaea* Walk., hair brown above, white below. Frons and face bright brown, with creamy bloom, hairs white to creamy, short and scanty above, longer and denser at sides of face; beard well developed, pure white. Basal segment of antenna pale yellow, second brown, both with creamy hairs, third segment and style brownish-black. Proboscis three times the head length, slender and with very small and inconspicuous labellae; palpi bright brown, with yellow hairs.

Thorax like that of *T. leucophaea* Walk., except that the stripes are about twice as wide and the median brown part is not much wider than the stripes. Scutellum entirely brown. Side margins with dense woolly dull yellow hairs mixed with longer creamy ones tipped with brown; postalar tuft and marginal hairs of scutellum creamy-yellow. Pleurae pale grey, with tufts of long silky white hairs. Legs yellowish-brown. Wings faintly smoky, brown along fore border.

Abdomen with a rather patchy light brown stripe at the sides and a narrow median dark brown stripe, which is broadened a little in the middle of the segments. Intervening pale grey stripes irregular in outline and markedly broader than any of the brown ones. Dorsal hairs mixed yellow and black; a hardly noticeable creamy fringe at the sides. Venter pale grey with short sparse silky white hairs.

Length: body 13 mm., wing 13 mm.

Holotype ♀ from north of Perth (French), in the National Museum.

This species is to be separated from *T. leucophaea* Walk. by the broader pale stripes on the thorax, and by the very much narrower dark brown median stripe and consequently much broader pale intermediate stripe on the abdomen. It is sufficiently distinct to warrant a separate name, although only one female is available. This is obviously the species referred to by Hardy as *T. leucophaea* Walk.

B.—*novae-hollandiae* subgroup.

Trichophthalma nigrovittata, n. sp.

A large stout species with brown thorax; abdomen dull orange with a broad black median stripe and black side margins; wings with fore borders brown.

♂, ♀. Eyes dark brown, almost meeting for a short distance below ocelli in the ♂, hairs brown above, creamy round lower margin. Frons yellow, with an inconspicuous black keel and silky yellow hairs; face brown, bare and shining; beard short, creamy. Basal segments of antenna testaceous, with creamy hairs, base of third segment testaceous, remainder and style brownish-black. Proboscis about as long as head, stout and with prominent labellae; palpi bright brown, darker at apex, large and prominent, with sparse short black hairs.

Scutum and scutellum dark brown, with a pale spot on each side at the medial end of the transverse suture. Dorsum covered with short black hairs; side margins with long dark grey hairs, not very densely arranged; postalar tuft dark grey; margin of scutellum with long creamy hairs. Pleurae creamy, with long creamy hairs arranged in patches. Legs entirely rich brown. Wings long, faintly smoky, brown along fore border.

Abdomen with a broad black median stripe throughout its length and broad black side margins to the first four segments; remainder forming a broad, dull orange stripe on each side of the median stripe. Dorsum with short black hairs; side margins with fairly dense, but short and inconspicuous, black hairs. Venter yellow, with pale yellow hairs in the middle and bright yellow ones at the sides. Male genitalia as in Text-fig. 4, *d*, *e*, *f*; aedeagus typically with one to two teeth on each side.

Length: both sexes, body 18 mm., wing 18 mm.; smallest specimen 14 mm., largest 20 mm.

Distribution.—New South Wales: Barrington Tops and Eccleston. Dates, January and February. Queensland: Gordonvale (October) and Port Douglas.

Holotype ♂ and allotype ♀ from Barrington Tops, in the Macleay Museum.

This species has a superficial resemblance to members of the *rosea* group, and may be readily separated from its allies by the abdominal banding. It was present in considerable numbers at Barrington Tops in early February, where it was taken feeding eagerly on *Leptospermum* sp. during any sunny spells.

Trichophthalma novae-hollandiae Macquart.

Hirmoneura novae-hollandiae Macquart, 1840.—*Rhynchocephalus gigas* Newman, 1841.—*Trichophthalma funesta* Walker, 1849.

Macquart, 1840, p. 19, Pl. 2, fig. 7, *a-c*; *nec* 1846, p. 101; *nec* 1850, p. 99.—Newman, 1841, p. 220.—Walker, 1849, p. 231.—Schiner, 1868, p. 110.—Lichtwardt, 1910*a*, pp. 373, 375, 377.—Hardy, 1924, p. 453.

"Thorace castaneo; abdomine fusco; pedibus rufis; alis fuscanis; Long. 8 l. ♀.

"Trompe noire, abaissée perpendiculairement, égalant en longeur la hauteur de la tête, assez épaisse, à lèvres terminales épaisses; labre, soies maxillaires et

palpes testacés. Face et front châtains, à duvet d'un gris jaunâtre pâle; face un peu convex. Yeux à duvet jaunâtre dans la partie supérieure, blanchâtre dans l'inférieure. Antennes: les deux premiers articles testacés; le troisième noir, ainsi que le style. Thorax à petits poils noirs; côtés à duvet blanchâtre et poils jaunes. Abdomen d'un brun noirâtre, à petits poils noirs; premier segment et base du deuxième à poils jaunes; ventre à poils jaunes; partie antérieure des segments testacée; oviductus châtain, à dernier article noir. Cuillerons jaunes, à poils jaunes. Ailes d'un brun grisâtre, à base et bord extérieure plus foncés. De la Nouvelle Hollande. Muséum."

A large uniformly chestnut-brown species, with bright brown legs and smoky wings suffused anteriorly with brown.

♂, ♀. Eyes blackish-brown, nearly meeting below ocelli in ♂, hairs brown above, creamy round lower margin. Frons covered with pale yellow bloom, no hairs, keel inconspicuous and covered with bloom except for a narrow median line; face bright brown, bare; beard bright pale yellow, more creamy in female. Basal segment of antenna pale yellowish-brown, second brown, both with pale yellow hairs, third segment brown at base, remainder and style black. Proboscis as long as head, stout and with prominent labellae; palpi rich brown, black at apex.

Scutum and scutellum rich brown, with, in fresh specimens, three very narrow inconspicuous paler longitudinal lines and a pale spot at the medial end of the transverse suture. Dorsum clothed with short black hairs; side margins with dense long yellow hairs, mixed with some black ones; postalar tuft yellow, with a patch of black; margin of scutellum with black hairs above, pale yellow ones below; the yellow throughout is much paler than is seen in *T. nigripes* Macq. Pleurae pale brown, with patches of yellow and creamy hairs. Legs uniformly rich reddish-brown. Wings somewhat smoky, bright brown along fore border.

Abdomen bright reddish-brown, duller brown in female, clothed dorsally with rather long black hairs mixed with a few yellow ones. On the second segment, a little anterior to the middle in the male and subbasal in the female, is a narrower inconspicuous transverse zone of pale yellow hairs. Marginal hairs yellow at base of second segment, remainder black. Venter pale yellow, with bright pale yellow silky hairs. Male genitalia like that of *T. nigrovittata*, nov.; aedeagus with one to two teeth on each side.

Length: both sexes, body 20 mm., wing 20 mm.; there are a few very small specimens, as small as 12 mm., but these do not differ in any other respect from the common type; there are also two females from North Queensland which are very large and have very long wings (body 23 mm., wing 27 mm.); in general, however, the size is very constant.

Distribution.—Queensland: Cairns, Gordonvale (10th January, 1920), Coen R., Claudie R., Banks Is. (18th January, 1920), Brisbane (6th October, 1916). Hardy also gives Stradbroke Is. and Torres Straits. New South Wales: Barrington Tops (early February, 1925, abundant; also December, 1921), Lake Macquarie, Wentworth Falls (14th and 21st December, 1923), Wee Jasper, near Yass (December, 1920). Victoria: Bright and North Melbourne. South Australia: a female in the Australian Museum, without further data. Hardy's record of this species from Western Australia is apparently based on two females of *T. costalis apicalis*, nov., in Dr. Ferguson's collection; I have seen no specimens from Western Australia.

Besides the variation in size noted above, there is also some variation in colour, some specimens being darker, others lighter than described here. The wings also vary, the large North Queensland specimens mentioned having uniformly brown wings, while others from the same State have almost clear wings. Despite the variation, this species is easily separated from *T. bancrofti* nov., by the entire absence of grey or yellow on the abdominal tergites and from *T. nigripes* Macq. by the colour, by the pale rather than mustard yellow hairs at the sides and by the characteristic genitalia of the latter. From *T. rufonigra*, nov., which it resembles very closely, it is separated by the subgroup characters. The synonymy is a little confusing, but a careful reinvestigation leads to the same conclusions that Hardy (1924) expressed. There is no doubt that this is the insect described by Macquart in 1840, but it is equally certain that it is not the species described under this name in 1846, which I cannot identify, nor that described in 1850, which is his *punctata*. The descriptions of *T. gigas* Newm. and *T. funesta* Walk. fit this species very well and can be definitely separated from *T. rufonigra*, nov., which is the only other species resembling it closely.

TRICHOPHTHALMA BANCROFTI, n. sp.

A large species with a uniformly grey thorax and a yellow abdomen with a variable median grey stripe. Legs yellowish-brown. Wings almost clear, faintly brown on fore border.

♂. Eyes blackish-brown, definitely separated but closest just below ocelli, hair deep creamy, almost white round lower border. Frons with creamy bloom and a narrow median bare brown line; face bright yellowish-brown, bare and shining; beard white, short and rather scanty. Basal segment of antenna yellowish-brown, second brown, both with short inconspicuous white hairs, third segment and style brownish-black. Proboscis as long as head, stout and with prominent labellae; palpi uniformly yellowish-brown.

Scutum and scutellum uniformly grey, covered with short fine creamy hairs; side margins with creamy hairs mixed with a few black ones; postalar tuft partly white, partly black; margin of scutellum with black hairs above, white below. Pleurae a paler grey than the mesonotum, with patches of silky creamy and white hairs. Legs bright yellowish-brown, hind tibia and tarsus darker reddish-brown. Wings almost clear, tinged with brown in cells Sc and R_1.

Abdomen yellow with a faint brownish tinge, covered with short black hairs, together with very inconspicuous creamy ones at the base of the second segment and longer creamy ones at the sides of the first and basal part of the second segment; remaining segments without developed lateral hairs. Second, third and fourth segments each with a large subtriangular grey patch, which is narrow basally and spreads out broadly along the apical edge of each segment; remaining segments almost entirely grey. This grey marking varies in extent, but is always conspicuous. Pleurae creamy with yellow sides, hairs same colour, very sparse and inconspicuous. Genitalia: aedeagus with three to four teeth on each side, otherwise like those described above.

♀. Differs from the male only in the extent of the grey on the abdomen, it here forming a broad band, widened at the apices, and leaving the sides only narrowly yellow.

Length: body 19 mm., wing 20 mm.; smallest a female 15 mm. long, largest a male 22 mm. long.

Distribution.—Queensland: Eidsvold (1-20 April, 1924, Bancroft), Gayndah, Brisbane (23rd November and 2nd December), Claudie R., Hughenden, Coen R.,

Rockhampton, Lindeman Is. (20th September).

Holotype ♂ and allotype ♀ from Eidsvold, 1st April, 1924, in the Macleay Museum.

This species is closest to *T. novae-hollandiae* Macq., but differs in the grey rather than brown thorax, in the yellow abdomen with grey markings, in the scantiness of the lateral abdominal hairs, in the creamy rather than yellow beard and lateral thoracic hairs, and in the great number of teeth on the aedeagus of the male. It closely resembles *T. intermedia*, nov., but is separated from it by the subgroup characters. *T. bancrofti*, nov., was not uncommon feeding on flowers or hovering in the air at the edge of Brigalow scrubs at Eidsvold. When hovering, it seemed to delight in dodging the sweeps of the net, always returning in a few seconds to the spot from which it had just vanished. This habit, common to all Trichophthalmas, is more marked in *T. bancrofti*, nov., than in any other species that I have observed. It is named in honour of Dr. T. L. Bancroft, of Eidsvold, to whom so many workers in zoology are indebted.

Trichophthalma nigripes Macquart.

Hirmoneura nigripes Macquart, 1840.—*Trichophthalma scapularis* Bigot, 1881. Macquart, 1840, p. 20.—Bigot, 1881, p. 18.—Lichtwardt, 1910*a*, p. 374.—Hardy, 1924, p. 453.

"Nigra; thoracis lateribus, abdominisque incisuris flavipilosis; pedibus nigris; alis fuscanis, limbo interno subhyalino. Long. 7 lin. ♀.

"L'individu type de cette espèce a eu des parties collées qui font soupçonner qu'elles n'appartient pas toutes à la même espèce. La tête, qui parait avoir été collée, et dont le front est couvert de colle, appartient peut-être à une Nemestrine ou à une Pangonie. La trompe est menue, abaissée perpendiculairement, un peu plus longue que la hauteur de la tête, à lèvres terminales peu distinctes. Les yeux sont nus. Les nervures des ailes ne diffèrent pas de celles l'*H. Novae-Hollandiae*. Patrie inconnue. Muséum."

A large stout species, of uniform colour varying from bluish-grey to rich purplish-brown. Lateral margins of thorax and base of abdomen with bright mustard-yellow hairs. Legs yellowish-brown, hind tibia and tarsus black. Wings smoky, with fore border brown. Genitalia characteristic.

♂, ♀. Eyes dark brown, distinctly separated in the ♂, with creamy hairs, paler round lower margin. Frons grey to creamy-yellow, with short sparse hairs of same colour at sides; face dark greyish-brown, almost entirely bare; beard bright pale yellow. First segment of antenna bright brown, second dark brown, both with short creamy hairs, third segment and style brownish-black. Proboscis a little shorter than the head, stout and with large prominent labellae; palpi with basal segment bright brown, apical segment dark brown.

Scutum and scutellum varying from dark bluish-grey to rich purplish-brown in specimens from different localities. Dorsum with short sparse black hairs; side margins, postalar tuft and margin of scutellum with dense long bright mustard-yellow hairs, which form a very prominent zone round the thorax. Pleurae grey, with long pale yellow hairs in front, mustard-coloured ones below and behind the wing-root and creamy ones above the legs. Legs brown, often darker dorsally, hind tibia and tarsus jet-black. Wings smoky, with brown fore border.

Abdomen short and broad, varying in colour from bluish-grey to rich purplish-brown; often the abdomen is brown and the thorax is distinctly grey.

Side margins with yellow hairs, longer and more prominent at the base, and interrupted by patches of black hairs at the apices of the second and third segments; in some females these marginal hairs are not at all prominent. Venter yellowish-grey, with rather sparse silky creamy-yellow hairs. Male genitalia: shape of distal end of ninth tergite (Text-fig. 6, *k*) absolutely characteristic; aedeagus without teeth, otherwise like rest of subgroup.

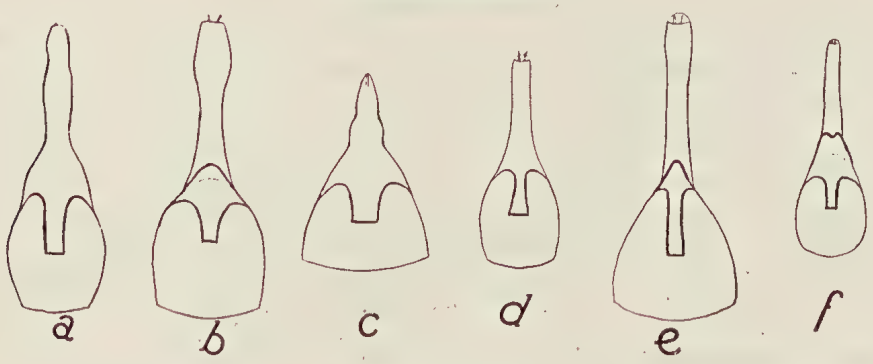
Length: body 20 mm., wing 19 mm.; smallest a male 16 mm., largest a female 24 mm.

Distribution.—Queensland: Eidsvold (29th April, 1924), Stradbroke Is. (5th December, 1913), Bribie Is. (November, 1915), Mt. Tambourine. New South Wales: Barrington Tops (early February, 1925), Hunter R., Lake Macquarie, Kendall, Broken Bay (31st December, 1923), National Park (21st February, 1925), Blue Mts. Victoria: Mordialloc.

This species is easily recognized, apart from the usually characteristic colour, by the zone of mustard-yellow hairs round the thorax, by the entirely black hind tibiae and tarsi, and by the characteristic ninth tergite of the male. The variation in colour is associated in a general way with a north-south distribution, a pair of entirely brown specimens from Stradbroke Is. forming one extreme and the very bluish-grey Victorian specimens the other. In between there are all shades, such as the Eidsvold specimens, which have a brown abdomen and a grey thorax, and a specimen from Broken Bay with a blue-grey thorax and a purplish-grey abdomen. Mountain forms in general conform to the southern type. There is a good deal of overlapping, but the general statement that brown predominates in the north and grey in the south fits the available facts very well. The season is the middle and late summer, but, like the rest of this subgroup, this species has a wide seasonal range. The habits, so far as I have observed them, are similar to those of *T. novae-hollandiae* Macq.

In regard to the synonymy, there is little doubt that Lichtwardt was correct in assigning Macquart's name to the species described above, although the original description was based on a composite badly preserved specimen. The colour of the lateral thoracic hairs is sufficiently distinctive to make his conclusion highly probable, especially in view of his statement that the description does not fit any of the species from other regions. The other references given clearly refer to this species.

C.—*rosea* group.



Text-figure 9.—Aedeagus of—*a*, *T. rosea* Macq.; *b*, *T. eques* Schin.; *c*, *T. albimacula* Walk.; *d*, *T. primitiva* Walk.; *e*, *T. laetilinea* Walk.; *f*, *T. ricardoae* Licht.

TRICHOPHTHALMA ROSEA Macq.

Hirmoneura rosea Macquart, 1846.—*Trichophthalma aurora* Walker, 1849.—*T. monotaenia* Schiner, 1868.

Macquart, 1846, p. 100.—Walker, 1849, p. 232.—Schiner, 1868, p. 110.—Lichtwardt, 1910*a*, pp. 376, 378.—Hardy, 1924, p. 454.

"Supra fusca subtus rosea. Thorace abdomineque vitta dorsale nigra. Pedibus rufis. Alis flavidis.

"Long. 6 l. ♀. Trompe menue, long de 2 l. Lèvres petites. Face et barbe à poils roses comme le dessous du corps. Front brun. Antennes fauves; troisième article ovale; style noir, de trois articles distincts. Yeux paraissant pointillés de noir, velus, bordés extérieurement de poils blancs. Thorax brun; une bande dorsale noire, prolongée sur l'écusson. Abdomen brun, à léger duvet grisâtre et bande dorsale noire. Pieds à duvet rose. Ailes légèrement jaunâtres; bord extérieur et base un peu roussâtres; nervures à peu près comme dans l'*H. Novae-Hollandiae*. De l'île Sydney dans l'Oceanie. Coll. de M. Bigot."

A large thickset ornate species, greyish in colour, with a broad black median stripe on thorax and abdomen and black side margins to abdomen; red hair at sides of abdomen; undersurface of male rose-pink; legs bright brown, wings clear.

♂. Eyes brown, contiguous for a considerable distance below antennae, covered with relatively long and dense tawny hairs, pale round lower margin. Frons small in extent, grey-brown, covered with short black hairs; face brown, with dense long red hairs mixed with a few black ones; beard rose-pink. Antennae bright brown, apex of third segment and style black. Proboscis a little longer than the head, rather slender and with small labellae; palpi brown, covered with long hair and hidden in facial hair, structure as in Text-fig. 2, *f*.

Thorax slate-grey, covered with short fine black hairs, reddish on scutellum; there is a conspicuous median longitudinal black stripe, wider on the scutellum; side margins dark beneath the hair; there are also two black spots on each side, one behind the fore margin and one behind the transverse suture; these are always small and the posterior one may be absent. Side margins with dense long creamy hairs mixed with some black ones so as to give a grey appearance; basally, forming a narrow zone close to the edge of the thorax, these hairs are distinctly dark red in colour. Postalar tuft black in front, creamy behind. Scutellum with creamy hairs at sides, black ones behind the black median stripe. Pleurae pale grey, with dense long rose-pink hairs. Legs bright brown, hind tibia and tarsus almost black. Wings glass clear.

Abdomen greyish-yellow, with a broad black median stripe and black side margins. The hairs at the base of the second segment are long and creamy, and the rest of the abdomen bears short creamy hairs on the pale parts and black hairs on the black, these being longer and denser at the sides, where they overlie the pale marginal hairs; towards the apex of the abdomen a progressively increasing number of red hairs appears on the dorsum. Side margins with long dense hairs which are red with white tips, the red becoming more marked towards the posterior end. Venter pale grey, with long rose-pink hairs and some white ones. Genitalia as in Text-fig. 4, *g*, *h*, *i*, and in Text-fig. 9, *a*; there is no posterior prolongation of the bulb of the aedeagus.

♀. Facial hairs brown instead of red; beard, pleurae and venter white with a variable amount of rose-pink, which, however, may be quite absent. The sides of

the beard, the basal part of the hairs at the sides of the thorax and the hairs at the sides of the abdomen are always a striking red colour.

Length: body 17 mm., wing 15 mm.; the largest is a female 20 mm. long and the smallest a male 14 mm. long.

Distribution.—I have seen 150 specimens of this species, mostly from the following localities near Sydney: Woy Woy, 2nd Sept., 1923, feeding on *Leptospermum* sp. in enormous numbers; National Park, feeding mainly on *Epacris microphylla*, from 2nd August to 13th September, 1925, much more abundant in the early part of August; La Perouse, August and September (Hardy); also Lane Cove, Roseville, Narrabeen, and Gosford. Undoubted specimens of this species are from Clarence R., N.S.W., and from Stanthorpe, South Queensland, 17th September, 1923 (Perkins). *T. rosea* Macq., in the Sydney District occurs in company with *T. eques* Schin., *T. albimacula* Walk., *T. primitiva* Walk. and *T. ricardoae* Licht.

This species is readily separated from *T. eques* Schin., to which it is closely related by the rose-pink of the male, by the red at the sides of the thorax and abdomen in both sexes, and usually by the male genitalia. In some very old specimens the red and pink are very much faded, but always remains sufficiently distinctive for easy separation. Text-fig. 1 and Pl. 1, figs. 1 and 2 show the general appearance very well. There is no doubt about the synonymy quoted above. Hardy also queries *T. bivitta* Walk. as a synonym, owing to an error in identification by White. The locality "l'île Sydney" is an error of Macquart's. He several times refers New South Wales species to Sydney Island.

TRICHOPHTHALMA EQUES Schiner.

Schiner, 1868, p. 110.—Lichtwardt, 1910*a*, p. 376.—Hardy, 1924, p. 455.

"Schwarzbraun; Rückenschild schiefergrau bestäubt mit fünf sammtschwarzen Längsstriemen; die mittelste ganz durchgehend und auch am Schildchen, wo sie sich zu einem Fleck erweitert, fortgesetzt; die beiden nächstliegenden kurz, an der Quernaht unterbrochen und gleich hinter derselben abgekürzt, die äussersten dem Rande knapp anliegend und den Saum desselben bildend; die Behaarung oben vorherrschend bräunlich, an den Seiten fast weiss, zottig, aber mit schwarzen Härchen gemengt; Brustseiten grau, dicht zottig, blassgelblich behaart. Hinterleib mit zwei breiten, parallelen Längsbinden von schiefergrauer Färbung, welche sich nach hinten zu allmälig verschmälern und am letzten Ringe ziemlich spitz enden: diese Binden lassen die Grundfarbe auf der Mitte in einer breiten, als Fortsetzung der Rückenschildsstrieme sich darstellenden Rückenstrieme und an beiden Seiten breit frei; die Behaarung an der lichteren Stelle hell, an den dunklen schwarz, an den Seitenrändern durchaus weiss und dicht zottig; Unterseite weisslich und weiss behaart. Kopf braun, Untergesicht grau bestäubt und weisslich behaart; Stirne mit kurzer schwarzer Behaarung, auch die Augen dicht behaart; Fühler lebhaft rostroth, die beiden Basalglieder weisschimmerend, der borstenartige Griffel deutlich dreigliedrig; Rüssel schwarz, Mundborsten an der Basis rostgelb. Beine lebhaft rothgelb, die Schenkel völlig weiss behaart. Flügel fast glashell, die Basis und die Subcostalader rostgelb; obere Zinke der Cubitalgabel mit der Radialader durch eine Querader nicht verbunden. 7‴. Ein weibchen aus Sydney.

"Die Art gleicht im Aussehen der *Tr. monotaenia*, ist aber von ihr durch die verschiedene Zeichnung des Rückenschildes und Hinterleibes sogleich zu unterscheiden".

This species is closely related to *T. rosea* Macq., from which it differs in the following respects: Frons with brown hairs instead of black. No trace of red or pink on any part of the body; the beard, pleurae, venter and lateral hairs of the thorax and abdomen being white to creamy-yellow. Lateral dark spots on thorax variable, but always larger than in *T. rosea* Macq., sometimes almost forming a complete stripe on the anterior half of the thorax. Male genitalia (Text-fig. 9, *b*) with bulb of aedeagus usually produced posteriorly into a small but conspicuous lobe overhanging the tube. The female does not differ in colour or markings from the male. The length is, in general, about 1 mm. less than that of *T. rosea* Macq.

Distribution.—New South Wales: National Park, French's Forest, Galston, Woy Woy. The dates are the same as for *T. rosea* Macq., but this species reaches its maximum later. It feeds usually on *Leptospermum* sp., *Epacris microphylla*, *Crowea saligna*, *Xanthorrhoea* sp. I have also seen specimens from Toronto and the Richmond River. Queensland: Stanthorpe, Brisbane and its vicinity, Eidsvold and Johnstone R., the last being the most northerly record for a member of this group. South Australia: A specimen without further data in the South Australian Museum may be this species, but its state of preservation is too bad for this record to be reliable.

Lichtwardt thought that this species merely represented faded specimens of *T. rosea* Macq. The abundant material now available (53 specimens) proves the separate identity of this species.

Trichophthalma bivittata Westwood.

Nemestrina (*Trichophthalma*) *bivittata* Westwood, 1835, *nec Trichophthalma bivittata* Thomson, 1869.

Westwood, 1835, p. 448; 1838, p. 86.—Lichtwardt, 1910*a*, p. 371; 1910*b*, p. 601.—Hardy, 1924, p. 454.

"Thorace cinereo; capite magno; oculis fulvescenti-pubescentibus; proboscide capite longiori; abdomine nigro, vittis duabus longitudinalibus latis albis; antennis pedibusque rufescentibus; alis hyalinis; nervi costalibus at basalibus fusco-rufis, reliquis nigris.—Long. corp. (probosc. excl.) lin. 7. Exp. alar. lin. 16.

Habitat in Nova Hollandia.—In mus. nostr.—Communicavit Dom. Shuckard."

It is impossible to place this species, the description not fitting any species known to me, with the exception of two greasy specimens of *T. eques* Schin., to which species, however, I do not feel justified in allotting it in the present state of our knowledge. The general opinion of writers on the family is that it belongs to the *rosea* group, and the few indications in the original description tend to favour this view. The type may turn out to be a greasy specimen of either *T. rosea* Macq. or *T. eques* Schin. Since this species is the genotype, it is important that the type should be located and redescribed on modern lines; it is possibly in the British Museum. There is no indication in Lichtwardt's writings that he saw the type, as Hardy suggests. It is to be noted that the names *bivittata* Westw. and *bivitta* Walk. have almost certainly been transposed in White's key (in Hardy, 1924). Lichtwardt considers *bivittata* Thom. a synonym; it is certainly a homonym, but is a synonym of *T. albimacula* Walk., as Hardy points out, and I do not think that Westwood's description could possibly be made to apply to Walker's species.

TRICHOPHTHALMA ALBIMACULA Walker.

Trichophthalma bivittata Thomson, 1869, *nec* Westwood, 1835.

Walker, 1849, p. 234.—Thomson, 1869, p. 476.—Lichtwardt, 1910*a*, pp. 380, 382.—Hardy, 1924, p. 455.

"Nigro-fusca, subtus alba, thorace albo bivittato, abdomine maculis albis bivittato, antennis ferrugineis piceo cinctis apice nigris, pedibus piceis, femoribus ferrugineis, alis subcinereis.

"Body very dark brown, white and thickly clothed with white hairs beneath; eyes piceous, thickly clothed with brown down; sucker black, dark ferruginous at the base, as long as the chest; feelers ferruginous, covered with a hoary bloom; third joint piceous, somewhat spindle shaped; chest with two white stripes; abdomen with two large nearly round white spots on each segment, with the exception of the three last, where the spots are very small; legs piceous; thighs dark ferruginous; clothed with white hairs; wings slightly grey; wing-ribs and fore border veins piceous; the other veins black; poisers tawny. Length of the body 5 lines; of the wings 10 lines. New Holland".

A medium-sized dark brown species, with two narrow grey thoracic stripes and yellow-grey abdominal spots or stripes. Wings clear. Legs deep brown.

♂, ♀. Eyes brown, meeting for a short distance below ocelli in ♂, hair brown above, white round lower margin. Frons and face pale grey, with white hairs mixed with a few black ones, longer on face; beard white with a few black hairs. Antennae with basal segments with white bloom and short white hairs, base of third segment yellow, remainder and style black. Proboscis about as long as head, slender and with small labellae; palpi brown, fairly plump, apical segment small and with well marked apical pit; the palp is covered with long hair and is almost completely hidden in facial hair.

Thorax dark brown, with pale grey side margins and two narrow longitudinal pale grey, almost white, stripes, which are widened at the transverse suture and converge somewhat posteriorly, where the grey colour mixes with the brown median part in front of the scutellum, the resulting colour being a darker grey than that of the stripes which remain distinct. Scutellum brown, irregularly grey in middle. Dorsal hairs black. The long dense hairs at the sides of the thorax are mostly white, but mixed with some black; postalar tuft black, with a little patch of white hairs; marginal hairs of scutellum creamy at sides, black in middle. Pleurae grey, with shaggy white hairs. Legs deep brown, black dorsally on tarsi. Wings clear, a little darkened in distal part of cells Sc and R_1.

Abdomen dark brown, each segment with a large subapical pale grey to creamy patch on each side of the mid line; these are variable in extent and colour, in many females adjacent patches are almost or quite continuous, the abdomen having the appearance of that of *T. eques* Schin.; the colour is grey, but varies from blue-grey to brownish-grey. Basal hairs of second segment creamy, remainder black on dorsum; side margins with dense black hairs, mixed with some white ones. Venter grey with dense silky white hairs. Two distinct types of male genitalia are found in this species. Specimens from National Park have the aedeagus exactly similar to that of *T. ricardoae* Licht. which also occurs in the same locality. The few males available from other localities have the type shown in Text-fig. 9, *c*. There appear to be no other differences between these two series and, though the genitalic differences are apparently constant, I do not feel justified in proposing separate names for the two.

Length: ♂, body 12 mm., wing 11 mm.; ♀, with ovipositor extended, 15 mm.

Distribution.—New South Wales: National Park, French's Forest, Bulli, Hazelbrook, Wentworth Falls, Yenda, Murrumbidgee (Hardy). The dates are all August or early September, except the Hazelbrook specimen, which was taken in December. It is one of the earliest Nemestrinids to appear, being second only to *T. primitiva* Walk. in time of appearance. Queensland: There is a single female from Eidsvold, no date, in the Gibbons Collection now in the possession of the Australian Museum. Food plants as under *T. rosea* Macq.

This species is easily recognized by the combination of narrow pale thoracic stripes with a longitudinally striped or spotted abdomen. Its appearance is well shown in Pl. 1, fig. 3. From *T. variolosa* Licht. it is to be separated by the thoracic markings and by the absence of bright yellow hairs as described below. *T. bivittata* Thom. is an undoubted synonym, as noted by Hardy. The specimen in the Vienna Museum identified by Lichtwardt as *T. bivittata* Westw. was probably also this species.

TRICHOPHTHALMA VARIOLOSA Lichtwardt.

Lichtwardt, 1910*a*, p. 386.—Hardy, 1924. p. 454.

"♂. Grosse, breite, gedrungene Art von der Gestalt der *Tr. rosea* Macq. Körper schwarz mit gelben Flecken auf dem Hinterleibe und gelber Behaarung. Kopf halbkuglig; Augen fast bis zur Hälfte der Entfernung zwischen Ocellen und Mund zusammenstossend. An den Ocellen ein Büschel schwarzer Haare. Augen sammetartig, dicht, weissgrau pubescent. Untergesicht und Kinn dicht weiss behaart. Zwischen den Fühlern ein Büschel und am Hinterrand der Augen ein Kranz hellgelber Haare. Die Oberseite des Thorax ist mit einem grauen Reif übergossen, unter welchem die aus 3 breiten Längsstriemen bestehende Zeichnung deutlich sichtbar bleibt. Der Anfang der Striemen ist ohne Reif und stellt deshalb schwarze, kurze Flecke dar, deren beide äussere ein wenig schief liegen und vor der Quernaht durch die Bestäubung undeutlich werden. Unterseite mit weisslicher Behaarung; Bauch mit weisslicher Bestäubung, durch welche die Sternite rötlich durchschimmern. An den Thoraxseiten stehen von der Schulter bis zur Flügelwurzel längere, weissgraue Haare; dicht vor der Wurzel und gleich dahinter sind die Haare hellgelb; diesen folgt wieder ein Büschel langer, schwarzer Haare an den Hinterecken. Schildchen rötlichgrau bereift, unten schwarz, an seinem Seiten—und Hinterrande mit abstehenden, gelben Haaren besetzt. Hinterleib schwarz. Auf jedem Tergit liegen je 2 gelbe Flecke neben der schwarzen Mittellinie. Der erste Tergit an der Basis des Hinterleibes trägt abstehende gelbe Haare; der zweite etwa rechteckige Flecke, der dritte halbmondförmige, am vierten und fünften nähern sich die Flecke, welche alle dem Vorderrande anliegen, ohne den Hinterrand zu erreichen, mehr der Form eines Dreiecks. Die Hinterleibsseiten sind, korrespondierend mit den Flecken, mit Büscheln gelber und schwarzer Haare geziert. Beine hellbraun; Schenkel mit wenigen weissen Härchen. Flügel im Verhältnis zu dem dicken Körper klein, hyalin. Eine besondere Eigentümlichkeit des Flügelgeäders, welche *Tr. variolosa* mit *Tr. rosea* Macq. teilt, ist das Zurückrücken von $C_1 + M_3$ gegen die Flügelwurzel. Die Stelle der Mündung in den Hinterrand des Flügels liegt ca. 2 mm. zurück gegen den sonst geraden Verlauf der "Diagonalader" (Fig. D.E.Z., p. 123, 1909). *Tr. rosea* Macq., *variolosa* n. sp., *bivittata* Westw. bilden durch diese Eigentümlichkeit zusammen mit der ganzen Form des Körpers eine Verwandtschaft, zu welcher wahrscheinlich noch *Tr. primitiva* Walk. gehört. Länge des Körpers 18 mm., Breite 7 mm.; Länge eines Flügels 13 mm., Breite 4 mm. Aus Adelaide, S.-Australien (ex coll. Saunders); Type, ein ♂ im British Museum".

I have not seen this species, which apparently combines the thorax of *eques* Schin. with the abdomen of *albimacula* Walk., but is separated from both by the bright yellow hairs on the face, the postocular region and behind the wing-roots. It seems to be more nearly related on eye characters and body form to *T. rosea* Macq. and *eques* Schin. than to *T. albimacula* Walk. The wings are very short. The type locality is Adelaide, South Australia, a district from which I have seen very few Nemestrinids.

TRICHOPHTHALMA PRIMITIVA Walker.

Trichophthalma tabanina Thomson, 1869.

Walker, 1857, p. 134.—Thomson, 1869, p. 476.—Lichtwardt, 1910*a*, pp. 381, 384.—Hardy, 1924, p. 456.

"Cana, lata, crassa, albido-pilosa, abdomine fasciato, pedibus piceis, alis subcinereis, venis nigris.

"Hoary, thick and broad, with whitish hairs which form bands on the abdomen; legs piceous; wings slightly greyish, veins black. Length of the body 6 lines; of the wings 12 lines. Australia".

A medium sized stout species, almost uniformly grey in colour, with black transverse markings on the abdomen and with short clear wings.

♂. Eyes greyish-black, contiguous for a considerable distance below ocelli, with black hairs above and white round the lower margin. Frons and face grey, with white hairs mixed with black ones; beard similar. Basal segments of antennae white with white hairs, third segment and style black. Proboscis about as long as head, slender and with small labellae; palpi black with long white hairs, well hidden, not so stout as in *T. rosea* Macq. and with apical pit distinct.

Thorax grey, with dark brown markings arranged as follows: A narrow median stripe extending the full length of the scutum; next on each side are two spots, the larger at the anterior margin and the smaller at the transverse suture; then comes a very narrow crescentic stripe extending from the anterior margin almost to fuse with the smaller of the spots just described; behind this there is a shorter broader stripe just in front of the lateral angle of the scutellum; further laterally still are two more spots, a narrower at the anterior margin and a broader just behind the transverse suture. The scutellum is grey enclosed in a brown margin. The dorsal hairs are grey, white in front of the scutellum. The dense hairs at the edges of the scutum and scutellum are white mixed with some black. Pleurae grey, with dense shaggy greyish-white hairs. Legs brown at base and beneath on femora, rest black. Wings short, glass clear.

Abdomen short and broad, segments black with basal half and apical edge grey, apical segments almost entirely grey. The black part is covered with rather short, sparse black hairs, while the paler basal half bears dense long greyish-white hairs. Side margins with alternating tufts of greyish-white and black hairs, corresponding to the markings on the dorsum. Venter grey, with dense long white hairs. Genitalia: aedeagus (Text-fig. 9, *d*) without posteriorly projecting lobe, basidistostyle larger and more upturned than in *T. rosea* Macq.

♀. The female abdomen differs from that of the male in that the black is towards the base of the segments, the apical half being broadly grey, and the basal edge being narrowly grey, the condition thus being exactly reversed. The pale hairs are much scantier and do not form the conspicuous bands seen on the ♂, the banding here being entirely due to the colour of the tergite and not to the hairs.

Length: Body 14 mm., wing 13 mm.; there is little variation.

Distribution.—New South Wales: National Park and Woy Woy; La Perouse (Hardy). This is the earliest Nemestrinid to appear and reaches its maximum before *T. rosea* Macq. becomes very abundant. The dates range from the 2nd August to the 13th September, only occasional wasted specimens being taken during the latter part of the season. Queensland: A male from Stradbroke Island, 15th July, 1906, does not differ appreciably from the Sydney specimens. Food plants as *T. rosea* Macq.

This species is readily recognized by its uniformly grey colour from all except *T. grisea*, nov., from which it is to be separated by the different thoracic and abdominal markings. Its appearance is well shown in Plate I, fig. 4, which also illustrates the characteristic way of feeding, the legs being still while the wings are vibrating rapidly. Hardy gives *T. tabanina* Thom. as a synonym and is undoubtedly correct, although the description does not agree in all details with this species, and had Thomson's specimen been from other than the Sydney district the synonymy would not be so clear.

Trichophthalma grisea, n. sp.

A rather small stout-bodied grey species, with median dark spots on the abdomen; wing short and clear.

♀. Eyes blackish-grey, separated by the full width of the ocellar triangle, with black hairs above and white ones round the lower margin. Frons with white bloom and a small bare patch of shining greyish-black just above the antennae; hairs white, collected into a tuft above the antennae and another in the middle of the frons. Face dark grey, with long white hairs mixed with black; beard longer than in *T. primitiva* Walker, white mixed with a few black hairs. Basal segments of antenna with white bloom and short white hairs, third segment testaceous at base, remainder and style greyish-black. Proboscis about the length of the head, fairly slender and with small labellae; palpi similar to *T. primitiva* Walk.

Thorax grey, with brown pattern arranged as follows: A broad median stripe on the anterior third, posterior third with a narrow median stripe, continuous with the brown one and extending to the scutellum; more laterally are three large brown spots or stripes, the anterior extending from the anterior margin to the transverse suture, the middle, which is the smallest, lies just behind the suture and is continuous with the anterior, to which it lies a little lateral, while the posterior spot is medial to the middle spot, commences just posterior to it, and almost reaches the scutellum. Scutellum grey, with brown posterior margin. The thorax in general shows much more brown than does *T. primitiva* Walk. Dorsal hairs black, sparse and short; lateral hairs long and dense, greyish-white mixed with a few black ones; marginal hairs of scutellum all jet black. Pleurae grey, with long shaggy greyish-white hairs. Legs with dark brown femora with long white hairs, rest of legs black. Wings short and glass clear; this specimen, of which only one wing is intact, has the tip of the oblique vein, M_{3+4}, absent, probably an individual aberration.

Abdomen light grey, slightly darker on the posterior half of each segment. The second, third and fourth segments each have a large round dark grey, almost black median spot. The dorsal hairs are short, sparse and black, except for the base of the second segment, which bears a transverse zone of white hairs. The marginal hair tufts are alternately black and white, the black being apical on each segment. Venter pale grey, with long shaggy greyish-white hairs.

Length: Body 10 mm., wing 11 mm.

Holotype, the unique female from Armadale, Western Australia, 1st September, 1912 (Hardy), has been returned to Mr. Hardy.

This is probably the western representative of *T. primitiva* Walk., from which, however, it differs so much as to warrant specific rather than subspecific rank. The markings on the thorax and abdomen and the black marginal hairs to the scutellum are the most striking points of difference. I have seen 59 specimens of *T. primitiva* Walk. and have found them quite constant in these respects.

TRICHOPHTHALMA LAETILINEA Walker.

Walker, 1857, p. 134.—Lichtwardt, 1910*a*, p. 381.—Hardy, 1924, p. 455.

"♂ et ♀. Nigra, subtus cana, capite thoracisque vittis quattuor canis, abdomine fasciis duabus testaceis, pedibus fulvis, alis vix cinerascentibus, venis fulvis. ♂. Thoracis abdominisque cano-pilosis. ♀. Thoracis lateribus cano-pilosis, abdominisque lateribus nigro-pilosis.

"♂, ♀. Black; hoary and with hoary hairs beneath; head hoary; thorax with four hoary stripes, and on each side with testaceous hairs in the male, and with hoary hairs in the female; abdomen with two shining testaceous bands, sides with shining testaceous hairs in the male, and with black hairs in the female; legs tawny; wings very slightly greyish, veins tawny. Length of body 6-7 lines; of the wings 12-14 lines. Australia".

A large stout dark brown species, with two narrow grey stripes on the thorax and narrow gold transverse bands at the apex of the second and third abdominal segments. Wings with faintly brownish tinge.

♂, ♀. Eyes dark brown, contiguous for a considerable distance below ocelli in male, with bright brown hair, white round lower margin. Frons white, with tufts of white hairs; face brown, projecting, the greater part with sparse hairs, but in the centre a dense fairly long tuft of white hairs surrounded by black ones; beard white, inconspicuous. Basal segments of antenna testaceous with short white hairs, base of third segment yellow, remainder rich brown, style black. Proboscis about one-third longer than the head, slender and with small labellae; palpi very different from those described above, easily seen and scantily haired, moderately slender and of the same thickness throughout, apical segment easily seen, twice as long as broad and with a large apical pit.

Thorax dark brown with grey margins and two fairly slender grey lines which are widened at the transverse suture and converge posteriorly, where the grey overflows the median brown in front of the scutellum, making this part predominantly grey. Scutellum brown, with an incomplete median grey stripe. Hairs on dorsum brown; lateral margin and scutellum with long dense creamy to white hairs; postalar tuft mostly black. Pleurae pale grey, with dense shaggy white hairs. Legs reddish-brown. Wings clear, with faint brownish tinge; the venation differs from other species of the group, except *T. ricardoae* Licht., in the position of M_{3+4} which, though definitely displaced, is much nearer to the rest of the oblique vein.

Abdomen dark brown with black hairs. Base of second segment grey, with a transverse zone of creamy hairs. Apical edge of second and third segments with a dense transverse band of bright pale gold hairs. Side margin with bright pale gold hair tufts, interrupted by small black tufts at the bases of the third and fourth segments. Venter pale yellowish-grey, with long fine white hairs.

Male genitalia: aedeagus (Text-fig. 9, *e*) with a small posterior lobe to the bulb; tube and also basidistostyle markedly longer, more slender and more upturned than in the species described above.

Length: Body 16-17 mm., wing 14 mm.; largest a female 20 mm. long, smallest a male 15 mm. long.

Distribution.—New South Wales: Sydney, Mosman, Ball's Head, Waterfall (Hardy), Wentworth Falls, Dorrigo. Victoria: Mallee Scrub, Narracan (Hardy). The dates range from the 28th August to 28th September in New South Wales, the later dates being for mountain specimens, and November (the Narracan specimen) in Victoria. Not having seen this species alive, I cannot say anything about its habits.

T. laetilinea Walk. and *T. ricardoae* Licht. differ from all the other species of the *rosea* group in their relatively bare face, slender prominent palpi, wing venation, abdominal markings and, to a minor extent, in the genitalia. *T. laetilinea* Walk. is most readily separated from *T. ricardoae* Licht. by its much larger size.

Trichophthalma ricardoae Lichtwardt.

Lichtwardt, 1910*a*, p. 385.—Hardy, 1924, p. 455.

"♂, ♀. Kleinere, dunkelbraune, mit weisser Linienzeichung geschmückte Art von gedrungenem, rauh behaartem Körper. ♂. Augen dunkelbraun, dichter und länger mit weisser, in das Gelbbräunliche spielender Behaarung besetzt, wie bei irgendeiner der vorstehend erwähnten australischen Trichophthalmen. An den Ocellen wenige schwarze Haare. Stirn-dreieck, Augenhinterrand und Kinn mit dichter, langer, weisslicher Behaarung. Ebenso ist die Brust und der Bauch bekleidet; nur ist die Farbe hier mehr schmutzig gelbgrau. Thorax, Schildchen und Hinterleib in der Hauptsache braun und ebenso behaart. Von der Schulter bis zur Naht stehen dunkelbraune, von dort bis zur Hinterecke und um das Schildchen herum weisslich gelbgraue, zottige Haare; ferner dicht unterhalb dieser Franse, kurz hinter der Flügelwurzel, ein auffallender Büschel längerer, fast schwarzer Haare. Auf der Oberseite des Thorax ziehen sich 2 weisse, schmale Streifen vom Vorderrand bis zum Schildchen. Vorn mag der Abstand zwischen den weissen Streifen etwa $\frac{1}{3}$, hinten etwa $\frac{1}{4}$ der Thoraxbreite betragen. An der Basis des Hinterleibes befindet sich die gleiche, hellere, lange Behaarung wie am Schildchen und zieht sich an den Seiten bis zur Hinterleibsspitze hinab. An den Vorderwinkeln des dritten und vierten Segmentes ist die helle Franse aber wirksam durch Büschel schwarzer Haare unterbrochen. Einen besonderen Schmuck des braunen Hinterleibes bilden jedoch feine, gelbliche Seidenhärchen, welche linienförmig die äussersten Ränder der dritten und vierten Tergite bekleiden. Beine hellbraun mit verdunkelten Tarsen. Schenkel mit dünner, längerer, heller Behaarung. Flügel hyalin; eigentümlich ist dieser Art der Verlauf der "Diagonalader": im Zickzack. Alle anderen Trichophthalmen zeigen eine gerade Diagonalader (vergl. über diesen Ausdruck D.E.G. p. 512 (1909)). Aus dem British Museum liegen mir 2 ♂ aus Adelaide, S.-Australien (R. Bakewell) vor; die ♂ messen 12 mm., das ♀ ca. 10 mm. Bei dem ♀ ist die Behaarung im ganzen kürzer und weiss, wo sie bei dem ♂ gelblich oder graulich ist; an den 4 ersten Gliedern der Legeröhre sind die kleinen Büschel schneeweisser Härchen an den Seiten besonders deutlich. Der Rüssel ist im Vergleich zu den anderen Arten dünn zu nennen. Ich widme die Art Miss Gertrude Ricardo—London in dankbarer Hochachtung für die mir geleistete Unterstützung meiner Arbeit."

A small fairly stout dark brown species, with two narrow grey thoracic lines, and bright transverse lines or spots on the abdomen. Wings faintly brown.

♂, ♀. Eyes dark brown, contiguous for a short distance below the ocelli in the male, hairs longer than usual, rich brown above, white round lower margin. Frons and face white, with white hair and a few black ones round oral margin; beard white, with a trace of pink. Basal segments of antenna black with white bloom and short hairs, third segment creamy at the base, rest bright brown, style black. Proboscis about as long as head, fairly slender with small labellae; palpi partly hidden by hair, but easily seen, apical segment much thinner than basal, longer and thinner than in *T. laetilinea* Walk., apical pit present.

Thorax rich dark brown, with pale side margins, and marked as in *T. laetilinea* Walk., except that the grey stripes are narrower and the scutellum is entirely brown. Marginal hairs mostly creamy, with a little brown in front of the wing-root and almost pure white at margin of scutellum; postalar tuft dark grey. Pleurae pale grey, with dense shaggy white hairs. Legs with femora bright brown with long white hairs, remainder of legs much darker, almost black on tarsi; in general markedly darker than in *T. laetilinea* Walk. Wings faintly brown anteriorly, otherwise clear; venation as in *T. laetilinea* Walk.

Abdomen short and broad, chocolate-brown in colour; base of second segment with a transverse zone of long pale creamy hairs; apices of second, third and fourth segments with a narrow dense transverse band of shining creamy hairs, which are interrupted in the middle of the fourth segment and may be very inconspicuous on the second. These bands appear to be easily rubbed and vary a lot in different specimens, some hardly showing any trace of them. Side margins with dense, silky white hairs interrupted by a patch of black ones at the base of the third segment and another at the base of the fourth. These marginal hairs are not nearly so marked in the females as in the males. Venter pale creamy-grey, with dense silky white hairs. Male genitalia: like *T. laetilinea* Walk., except that the posterior lobe of the bulb of the aedeagus is larger and is bifurcate apically (Text-fig. 9, *f*).

Length: Body 12 mm., wing 11 mm.; largest a female 14 mm. long, smallest a male 10 mm. long.

Distribution.—South Australia: Adelaide (Lichtwardt), type locality. New South Wales: National Park, feeding on *Epacris*, 23rd August to 13th September, the rarest of the species taken there; Toronto (Ferguson), these specimens are mentioned by Hardy as a small variety of *T. laetilinea* Walk.

This species is very close to *T. laetilinea* Walk., from which it is separated by its much smaller size, entirely brown scutellum, less conspicuous abdominal bands and male genitalia. The two species appear to be constant and there does not appear to be any geographical separation. The above description, based on specimens from National Park does not agree completely with Lichtwardt's, but I feel satisfied that this is the eastern representative of his species.

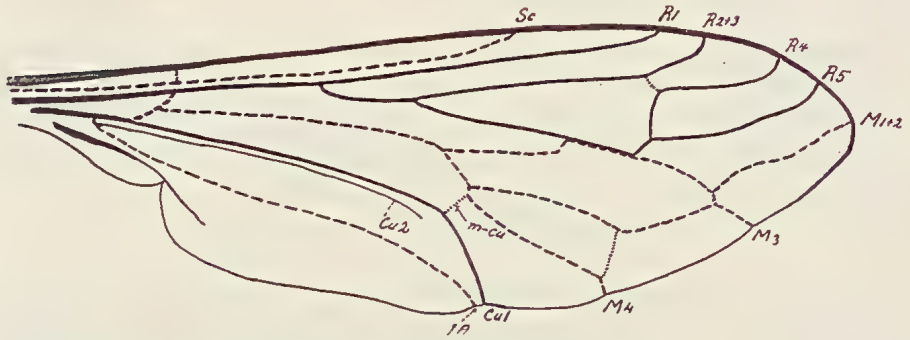
Genus Exeretoneura Macquart.

Macquart, 1846, p. 105.—White, 1914, p. 63.—Hardy, 1924, p. 457, figs. 4 and 10.

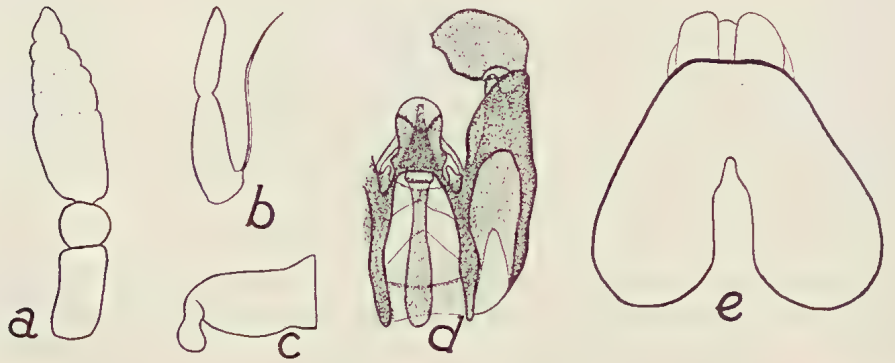
Definition.—Eyes bare, markedly dichoptic in both sexes; ocelli present. Proboscis short, Leptid-like, palpi well developed. Antennae with first and second segments short, cylindrical, third segment large, broad, laterally compressed, divided into a large basal and five small apical subsegments, no style.

Wing with R_{4+5} forked, *c-v* between R_{2+3} and R_4, M_{1+2} markedly overlapping R_{4+5}, M_1 and M_2 not separated beyond the oblique vein, M_4 ends in wing margin between M_3 and Cu_1, *c-v* between M_{1+2} and M_3 and between M_3 and M_4, C continuous all round wing margin. Tibiae with two apical spurs, the medial spur on the fore legs being reduced or absent. Male genitalia with well developed basistyle, and large characteristic distostyle; no basidistostyle; aedeagus separate; anal lobes fairly large, membranous. Lamellae of ovipositor small and with a minute terminal lobe.

Genotype, *Exeretoneura maculipennis* Macquart, 1846. Tasmania.



Text-figure 10.—Wing of *Exeretoneura maculipennis* Macq.



Text-figure 11.—*Exeretoneura maculipennis* Macq. *a*, antenna; *b*, palp and maxilla; *c*, ovipositor; *d*, dorsal view of parts of male genitalia seen after removal of ninth tergite; *e*, ninth tergite and anal lobes of male.

This genus is very different from any of the other Australasian genera, and shows a confusing mingling of primitive and specialized characters. In many respects the resemblance to the Leptidae is very close. The head and eyes are distinctly of a generalized type, while the mouth parts are more specialized than those of *Trichophthalma* in the greater development of the labellae and in the reduction of the maxillae to delicate, almost hair-like structures; the palpi are of a slightly less specialized type. The antennae are Tabanid-like and the tibial spurs are also seen in the Tabanidae and Leptidae. The wing is primitive in shape, in the forking of R_{4+5} and in the disposition of M_4, in which it is intermediate between the condition found in some specimens of *Atriadops javana* Wied.

and that characteristic of *Nycterimorpha*. The overlapping of R_{4+5} by M_{1+2} and the fusion of M_{1+2} distal to the oblique vein are, on the other hand, indications of a degree of specialization which is not seen in *Trichophthalma*.

It is difficult to assess the phylogenetic value of genitalic characters, as there are greater differences in the Tabanoidea between genera than between families, but it may be stated that these parts are much less specialized than in *Atriadops* and *Trichopsidea*. The same may be said in regard to the ovipositor, which is not unlike that of *Trichophthalma*. The general body form is more archaic than in any of the other Australasian genera. Taking everything into consideration, one may conclude that *Exeretoneura* is the most archaic of the Australasian genera and belongs to an earlier wave of migration than does *Trichophthalma*, and that it has followed a separate line of evolution and undergone certain specializations of its own. The distribution of the genus in Tasmania and on the mountains of Eastern Australia suggests that its nearest relatives will probably be found in South America. If any Nemestrinid is found in New Zealand, it is likely to be of this type.

The habits of these flies are unlike those of any other members of the family with which I am acquainted, and resemble those of certain Leptidae, such as *Chrysophilus*, with which they have also structural affinities. At Barrington Tops, *Exeretoneura maculipennis* Macq. was present in thousands and was always to be found clinging to grass stems, or flying in a leisurely fashion close to the ground; they were never seen feeding on the flowers where Trichophthalmas were so abundant. Their flight is slow and their note is little more than a dull whirring, strikingly different from the loud high-pitched characteristic note of the Trichophthalmas. In the mornings they were so lethargic from cold that they could be picked up in the fingers in any quantity. No information is available as to the life history.

EXERETONEURA MACULIPENNIS Macquart.

Macquart, 1846, p. 106, Pl. 9, fig. 6.—Lichtwardt, 1909, p. 651.—White, 1914, p. 64, fig. 8.—Hardy, 1924, p. 458, fig. 12.

"Nigra. Thorace cinereo tomentoso, vittis nigris; scutello testaceo. Abdomine incisuris albis. Pedibus testaceis. Alis fuscomaculatis. (Tab. 9, fig. 6).

"Long. 6 l. ♀, sans l'oviductus. Face et front noirâtres, à duvet grisâtre sur les côtés. Le premier article des antennes noir; le deuxième testacé. Abdomen noir; bord postérieur des segments à duvet blanc, ventre testacé, à duvet blanchâtre. Pieds d'un testacé terne, à duvet blanchâtre. Ailes un peu jaunâtres; une tache brune à l'extrémité des cellules basilaires; une autre plus petite à la base des sous-marginales.

"De la Tasmanie. Muséum".

A medium sized long-bodied species. Frons nearly as wide as long. Thorax dark grey with three narrow black lines. Abdomen black with narrow silvery transverse bands. Wings smoky with patches of brown.

♂, ♀. Eyes reddish-brown, bare, widely separated; anterior ocellus far removed from the others and lies midway between the vertex and the antennae. Frons grey, nearly as broad as long, with sparse long black hairs; face deeply excavated, with mixed black and gold hairs at the sides of and below the antennae. Antennae with basal segments brown, clothed with black hairs, third segment black, bare, broad and laterally compressed. Proboscis and palpi bright brown; beard white.

Thorax dark grey with paler side margins and three longitudinal narrow black lines; hairs sparse and short, mostly black with a few paler ones; side

margins with longer denser black hairs mixed with pale yellow ones. Scutellum brown. Pleurae pale grey, with patches of dense long silky white hairs, one on proepimeron, one in front of, and one behind the wing-root. Legs yellowish-brown, darker dorsally on tarsi; hind legs all brown. Wings somewhat smoky, with three dark patches, one a little distal to the forking of Rs, another covering the forking of R_{4+5} and the third round the forking of M and of M_{3+4}; this last may be fused with the first; there is also a slight darkening around M_{1+2} just distal to the oblique vein.

Abdomen black, segments with narrow brown hind margin and indications of brown side margins, which colour is somewhat more extensive in the female. This sex is in all respects paler than the male. Second segment with the side margins silvery; third to the sixth segment with a zone of dense silvery hairs on the hind margin, forming a narrow brilliant transverse band. Venter greyish-brown with white hairs. Genitalia of ♂ and ovipositor of ♀ as in Text-fig. 11, *c*, *d*, *e*.

Length: Body 14 mm., wing 12 mm.; largest a female 16 mm. long, smallest a male 11 mm. long.

Distribution.—Tasmania: Cradle Mt. (January), Hobart (March), Bellerive, on beach, March (Hardy). New South Wales: Kosciusko (February and March), Barrington Tops (January and February, very abundant).

To be separated from *E. angustifrons* Hardy by the smaller size, wider front, and the presence of mottling on the wings.

Exeretoneura angustifrons Hardy.

Hardy, 1924, p. 458, fig. 13.

"Differs from *E. maculipennis* Macquart by having a very narrow front, which, near the antennae, does not exceed half its length. Head black, two tufts of yellow hairs above the antennae and the hair on the face also yellowish. Thorax blackish brown with three black median stripes; the majority of the hairs are yellowish. Scutellum brownish black. Abdomen black, which colour merges into yellowish brown at the apex on the female only; pubescence yellowish and white; venter yellow brown. Legs and veins of the wing yellowish. Male considerably more pubescent than the female and its front narrower. Length: ♂ 15 mm.; ♀ 19 mm.

"*Hab.*—Victoria: Gisborne, holotype ♂ and allotype ♀, a pair taken *in copula*, by Mr. G. Lyell, 11.3.1917; Gippsland, 1 ♂, 1 ♀, paratypes in the National Museum. New South Wales: 1 ♂ paratype from Ebor, taken by Dr. A. J. Turner, 8.1.1914. In the Queensland Museum".

Little need be added to this description, beyond noting that the wings do not show the characteristic markings of *E. maculipennis* Macq. and that the third segment of the antenna is not so broad, but that the ovipositor of the ♀ and the genitalia of the male are similar in the two. There are specimens before me from Bright and Mallee in Victoria in addition to some of the above localities.

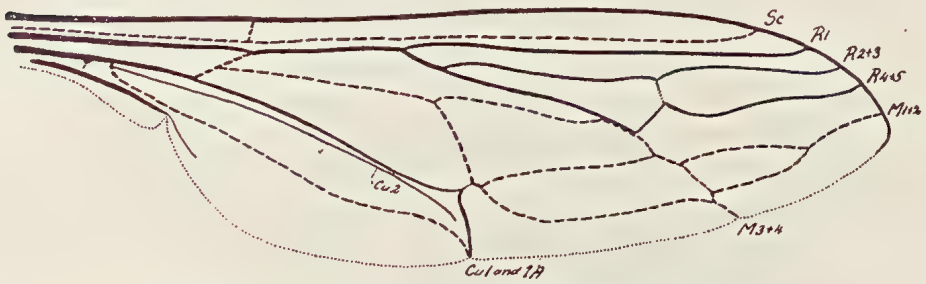
Genus Trichopsidea Westwood.

Westwood, 1839, p. 151, Pl. xiv, fig. 9, *a-f*.—Wandolleck, 1897, p. 250, fig. 6.—Hardy, 1924, p. 456, figs. 3 and 9.

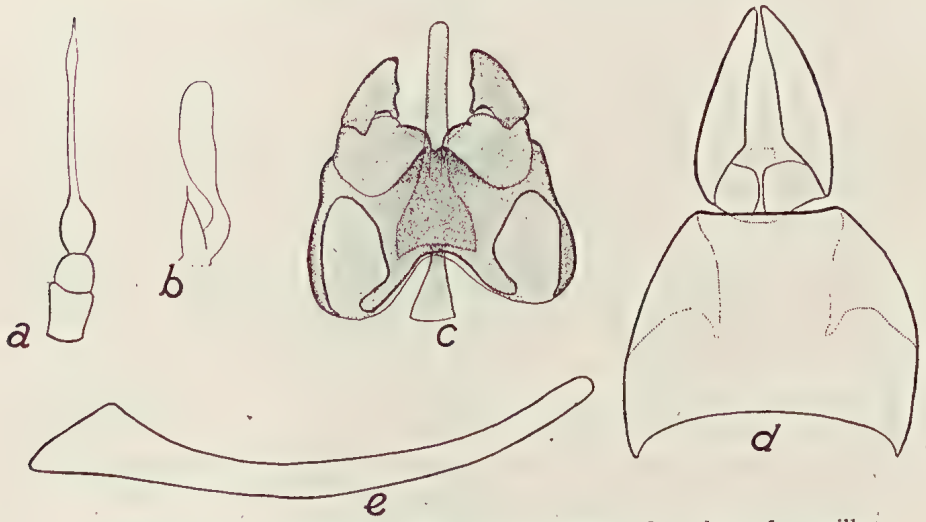
Definition.—Eyes bare, almost meeting below ocelli in ♂, widely separated in the ♀; in the ♂ the facets round the lower border are much smaller than the rest, they are uniform in size in the ♀. Proboscis a very short stiff tube; palpi a little shorter than the proboscis. Facial hair abundant, hiding the mouth parts. Antennae with basal segment cylindrical, second spherical, third small

and continuous with the unjointed style. Wings with R_{4+5} not forked, *c-v* between R_{2+3} and R_{4+5}, M_{1+2} overlapping R_{4+5}, M_1 and M_2 fused apically, M_4 fused apically to M_3, forking of M_{3+4} beyond *m-cu*, C ends at tip of wing. Male genitalia with basistyles, aedeagus and ninth sternite fused together, but basistyles projecting apically and bearing moderately developed distostyles; free part of aedeagus a long slender tube; anal lobes large, chitinized. Ovipositor greatly elongate.

Genotype, *Trichopsidea oestracea* Westwood, 1839. Australia.



Text-figure 12.—Wing of *Trichopsidea oestracea* Westw.



Text-figure 13.—*T. oestracea* Westw.; *a*, antenna; *b*, palp and maxilla; *c*, dorsal view of parts seen after removal of ninth tergite; *d*, ninth tergite and anal lobes; *e*, ovipositor.

This genus belongs to a group of related genera which have reached Australia from the Oriental Region, probably much later than the date of arrival of *Exeretoneura* or *Trichophthalma*. The small mouth parts, the reduced third antennal segment, which is continuous with the style (Text-figs. 11*a*, 13*a*, 14*b* are from cleared preparations), the thickset type of body with flattened head in all but the aberrant *Nycterimorpha*, the venation, and the structure of the male genitalia and of the female ovipositor (in the case of *Trichopsidea* and *Atriadops*), all serve to link these genera and to separate them from those described above. Of this group, *Trichopsidea* and *Atriadops* are older than the others, *Nycterimorpha*

being far the most specialized and aberrant Nemestrinid from this region. *Trichopsidea* is less specialized than *Atriadops* in the male genitalia, in that the fusion and reduction seen in the latter genus have not proceeded nearly so far, but the venation is a little more specialized. It was probably the earliest of this group to reach Australia. The arrangement of the facets in the male eye resembles the condition found in *Nycterimyia*. The resemblance to the Palaearctic *Dicrotrypana* is, according to Lichtwardt (1909), very close. The distribution of the genus is from New Guinea to Tasmania on the east and also North-west Australia.

TRICHOPSIDEA OESTRACEA Westwood.

Westwood, 1839, p. 151, Pl. xiv, fig. 9, *a-f*.—Macquart, 1840, p. 119, Pl. iii, fig. 1, *a-f*; 1846, p. 107.—Walker, 1849, p. 235.—Wandolleck, 1897, p. 250, fig. 6.—Lichtwardt, 1909, p. 647; 1910*a*, p. 387; 1919, p. 277.—White, 1916, p. 260.—Hardy, 1924, p. 457.

"Obscure nigra; facie marginibusque segmentorum abdominalium fulvo-pilosis; pedibus rufescentibus, femoribus ad basin obscuris; alis hyalinis, costa obscuriori nervisque costalibus crassioribus.

"Long. corp. lin. 4½. Expans. alarum lin. 10.

Habitat in Nova Hollandia. In Musæo nostro".

A fairly small thickset pale golden species, with glass-clear wings and short testaceous legs.

♂, ♀.—Eyes dark brown; anterior ocellus not markedly removed from the others. Frons of ♀ dark brown with black hairs in its upper part, pale on lower half and covered with dense short pale golden hairs; that of male with yellowish hairs below point of approximation of eyes. Face with longer silky creamy-yellow hairs; beard long and dense, of same colour, completely hiding the mouth parts. Antennae orange-yellow.

Thorax grey, with darker markings and with alternating patches of black and shining pale gold hairs, which seem to form an irregular pattern; side margins and scutellum with long dull creamy hairs. Pleurae pale grey, with abundant long creamy hairs. Legs short, rich orange in colour, hind legs darker. Wings glass-clear with brown veins.

Abdomen short and broad, segments with basal half black and apical half brown; all the brown and part of the black covered with silky pale golden hairs, which form broad bright transverse bands. Venter adorned similarly to the dorsum. Male genitalia and female ovipositor as in Text-fig. 13, *c*, *d*, *e*.

Length: Body 12 mm.; wing 13 mm.; length of ovipositor 3 mm.

Distribution.—New Guinea (Lichtwardt). North-west Australia: Broome, 15th November, 1911 (French) in the National Museum. Queensland: Port Denison, Eidsvold, Toowoomba. Dates 30th November to 15th March. New South Wales: Como, 18th December, 1897, a male in the Macleay Museum; two other specimens without further data. Victoria: Bunyip (Hardy). Tasmania: Recorded by White, Macquart and Walker.

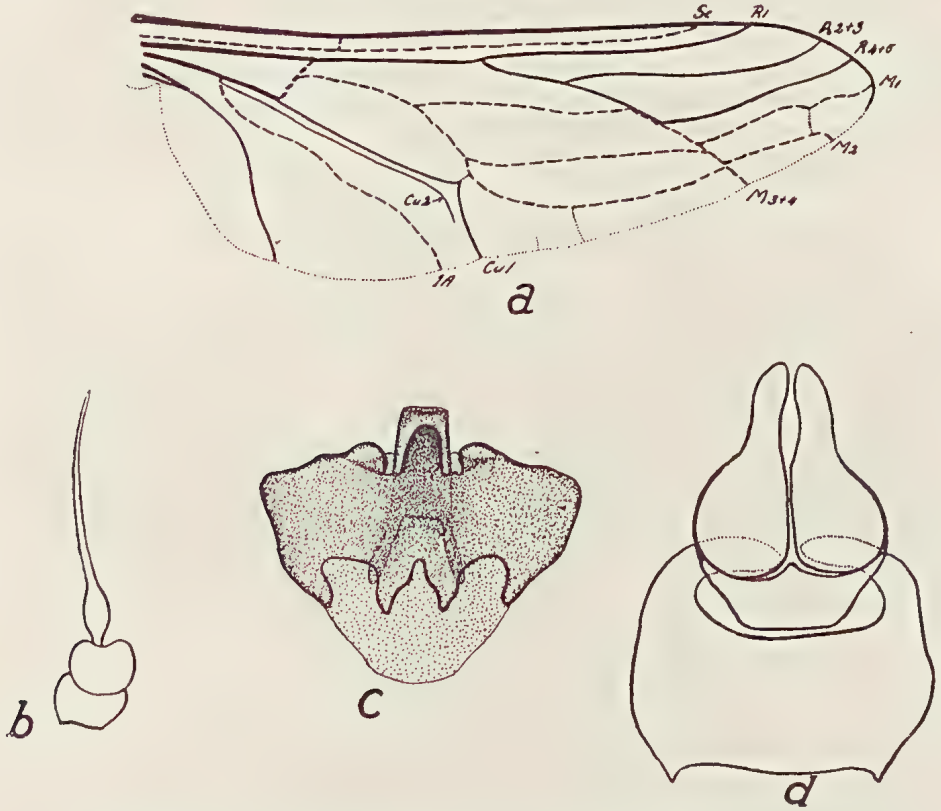
These flies are very active in their flight and are exceedingly difficult to capture. They hover motionless close to the ground for a few seconds and then dart away a few feet or yards, to hover there for a little while; they never remain long in the one spot or return to it as do the Trichophthalmas. They have not been observed feeding, nor is anything known of the life history.

Genus Atriadops Wandolleck.

Colax Wiedemann, 1824, *nec* Hubner, 1816.

Wandolleck, 1897, p. 246.—Wiedemann, 1824, p. 18; 1830, p. 260.—Lichtwardt, 1909, p. 649.—Hardy, 1924, p. 456, figs. 2, 8.

Definition.—Eyes bare, nearly meeting in ♂, markedly separated in ♀; *ocelli absent*, but ocellar triangle present. Antennae very small, first and second segments short and broad, third greatly reduced and continuous with a long style. Proboscis and palpi invisible; facial hair abundant. Wings with R_{4+5} unforked, M_{1+2} overlapping R_{4+5}, M_1 and M_2 separate beyond oblique vein, M_4 either joining M_3 or ending in the wing margin between M_3 and Cu_1, C apparently ending at apex



Text-figure 14.—*Atriadops javana* Wied.; *a*, wing; *b*, antenna; *c*, parts seen after removal of the ninth tergite of the ♂ (dorsal view); *d*, ninth tergite and anal lobes.

of wing, crossveins inconstant. Genitalia with ninth tergite produced ventrally into hook-like processes and with all parts of ninth sternite fused together and to aedeagus; distostyle no more than a small projection, free part of aedeagus a short broad tube; anal lobes large, heavily chitinized. Lamellae of ovipositor exceedingly long and thin.

These flies were thought by the older writers to be related to the Oestridae, and the superficial resemblance to members of that family is rather striking. The most interesting features about this genus are the absence of ocelli, and the great reduction and simplification of the parts of the genitalia made up from the ninth sternite and its appendages, together with the increase in size and strength of the ninth tergite and anal lobes, all these modifications being carried in this genus far beyond the condition found in *Trichopsidea*. The venation presents certain interesting features. M_4 may end in M_3, as shown in Text-fig. 14, *a*, or it may end in the wing margin basal to, but quite close to, M_3. The *c-v* between M_1 and M_2 may be absent, while the position of M_2, ending well behind the apex of the wing, is unusual. The accessory crossveins joining M_4 to the hind margin vary from one to four in number. C appears to end at the apex of the wing, but is so pale that it is difficult to determine just how far it extends. The distribution of the genus is wide, species being known from South America, Africa, and from the Oriental and Australian Regions, the last two forming a continuous distribution of one species. One must note that there are definite venational differences between the species from the separated areas of distribution, but that the figures of the entire insects show a marked similarity throughout.

ATRIADOPS JAVANA Wiedemann.

Colax javanus Wiedemann, 1824.—*C. variegatus* Westwood, 1848.—*Atriadops westwoodi* Lichtwardt, 1909.

Wiedemann, 1824, p. 18, Pl. i, fig. 8; 1830, p. 26, Pl. ix, fig. 11.—Westwood, 1848, p. 118, Pl. 18, fig. 5.—Walker, 1850, Pl. v, fig. 4.—Wulp, 1886, p. 26; 1896, p. 69.—Wandolleck, 1897, p. 246, fig. 1.—Lichtwardt, 1909, pp. 649, 650.—Hardy, 1924, p. 456.

"Fühler rot; Untergesicht gelblich bis licht-graulich, weisslich behaart, Stirn licht braungrau mit grauweisslichen Haaren. Seiten des Rückenschildes und Brustseiten sehr stark weiss behaart. Hinterleib querrunzelig, die Spitzenränder der Abschnitte nämlich erhoben. Flügel braun, an der Rippe ein wenig lichter, gegen die Spitze hin mit einem weisslichen Flecke unter der Rippe; am inneren, fast wasserklaren Rande einige schwärzlich braune Punkte, von welchen der der Wurzel nächste grösser ist, Schwinger gelblich. Schenkel ocherbraun, Schienen und Füsse gelblich, 3 ziemlich schmale Pulvillen".

A medium sized thickset species, dark brown in colour, with dark brown wings mottled with white and with short brownish legs.

♂, ♀. Eyes brownish-black; frons dark brown with short pile and scattered brown hairs; antennae brown, sunk beneath a transverse groove; facial hair dense, brown above in middle, white at sides and below. Thorax dark brown, almost black, covered with brown hairs which are denser and longer at the sides and round the scutellum, where they merge into long creamy hairs at the edges of the mesonotum; a marked postalar tuft of long dense silky white hairs; pleurae light brown, with long dense creamy and brown hairs. Legs short, stout and rather hairy, femora brown, rest of legs yellowish. Wings dark brown with a white patch extending from R_1 to the middle of that part of the oblique vein formed from R_{4+5}; the posterior margin is variable, being in some specimens (*javana* Wied.) clear, in others (*westwoodi* Licht.) markedly darkened, while sometimes it is impossible to say to which group a specimen should be allotted; similarly the small dark markings on the clear zone are quite variable in number and extent, even in the two wings of one specimen; there are also variable patches of paleness in cells M, Cu_2 and 1A. Abdomen short and broad, dark reddish-brown,

with transverse zones of shining brown hairs; venter reddish-brown with silvery hairs. Male genitalia as in Text-fig. 14, *c* and *d*. Ovipositor as in *Trichopsidea oestracea* Westw. (Text-fig. 13, *e*).

Length: Body 11 mm., wing 11 mm.; largest 14 mm., smallest 9.5 mm.

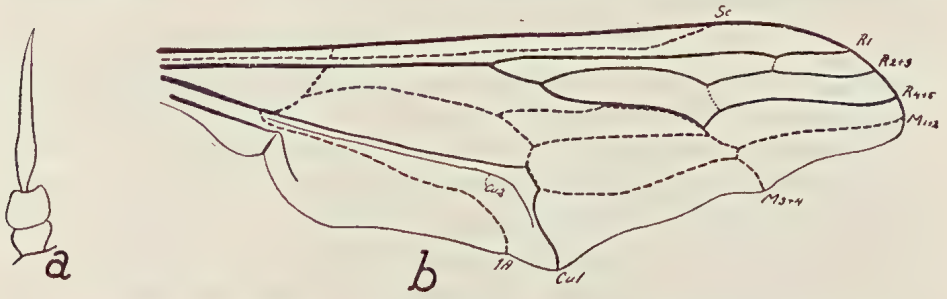
Distribution.—In the Oriental Region this species has been recorded from Ceylon, China, Sumatra and Java. In the Australasian region Lichtwardt gives New Guinea, and Palmerston and Cape York in North Queensland. Specimens are before me from Cape Greville, Port Curtis, Port Denison, Gayndah, Brisbane (several) and Toowoomba in Queensland. In New South Wales there are two males from Coff's Harbour (14th February, 1924, Ferguson). The Brisbane dates are early January, with the exception of one female taken in February. The Toowoomba specimen was taken on the 4th December.

In regard to the synonymy, Lichtwardt sinks *variegata* Westw.; I find that Westwood's description and figure agree very well with the specimens before me. I have seen specimens which correspond with *westwoodi* Licht., as well as some which agree with *javana* Wied., besides intermediates. Not having been able to find any characters in the genitalia or other parts on which they could be separated, I have reduced Lichtwardt's name to synonymy. Dr. Ferguson informs me that he took one of his specimens clinging to a grass stem with the legs bunched together and the body standing out at an angle from the stem. There is no other information available as to the habits.

Genus Nycterimyia Lichtwardt.

Lichtwardt, 1909, p. 647.—Bequaert, 1925, p. 18.

Definition.—Eyes bare, facets in male larger above than below; ocelli present. Antennae with basal segments short and broad, third segment constricted at base



Text-figure 15.—*a*, Antenna of *Nycterimyia papuana* Beq. (after Bequaert, 1925); *b*, wing of *N. horni* Licht. (adapted from Lichtwardt, 1912).

and forming little more than a part of the style, with which it is continuous. Proboscis and palpi not visible; face deeply excavated, facial hair abundant. Legs incrassate. Wings with R_{4+5} not forked, M_{1+2} overlapping R_{4+5}, M_1 and M_2 not separated beyond oblique vein, M_4 ending in M_3, *c-v* between R_1 and R_{2+3} and between R_{2+3} and R_{4+5}, Cu_1 in some fused for a little way with M_4, thus eliminating *m-cu*; wing margin has characteristic wavy outline, C ending behind apex in some if not all. Genitalia of male and female not described.

Genotype, *Trichopsidea dohrni* Wandolleck, 1897. Sumatra.

The genus seems to be closely related to *Atriadops* Wandol., the general appearance, judging from Wandolleck's figure, being very similar and the mouth

parts, antennae and venation also indicating close affinity. The legs, however, are much modified and the venation indicates a further degree of specialization in the fusion of M_1 and M_2. The ocelli are here retained, though lost in *Atriadops*. The genus is recorded from Natal, Formosa, Sumatra, Mapor, Andaman Is., New Guinea and Queensland. Four of the seven known species are from Indo-Malaya and two from the Australasian Region.

NYCTERIMYIA HORNI Lichtwardt.

Lichtwardt, 1912, p. 27.—Hardy, 1924. p. 459.

"Ein ♂ aus Kuranda, Nord-Queensland II, 1910, Type im Deutsch. Entom. Mus.

"Die schöne, zimtbraune Fliege ist der *N. Dohrni* Wand. so ähnlich, dass ohne Flügelabbildung eine Beschreibung recht schwer wäre. An dem flachen Kopf ist nur der Ocellenhöcker schwarz. Die Augen, welche im unteren Drittel kleine Facetten, in den oberen Dritteln aber deutlich grössere zeigen, sind durch einen schmalen, vertieften Einschnitt getrennt. Bei den Weibchen, wenigstens bei den beiden mir bis jetzt bekannt geworden, ist die Facettierung der Augen gleichmässig. Im übrigen ist der Gattungsdiagnose etwa noch anzufügen, dass die Ecken der Flügel bei den einzelnen Arten verschieden gebildet sind, Der Hauptunterschied der neuen Art (Fig. 1) liegt in der Lage der Fensterflecken der Flügel. Das Fenster in der Analzelle der *N. Dohrni* ist breit und nach vorn ziemlich gerade abgeschnitten; bei *N. Horni* n. sp. ist der Fleck vorn konkav mit einer langen, spitzen Zunge an der oberen Ecke. Erstere Art zeigt in der hinteren Basalzellen ein grosses rundes Fenster; bei der neuen Art ist die genannte Zelle bis auf zwei ganz kleine Fleckchen dunkel. Länge des Körpers 9 mm., des Flügels 11 mm.

"Ich benenne die Art Herrn Dr. Horn-Dahlem zur Ehre".

Unknown to me.

NYCTERIMYIA PAPUANA Bequaert.

Bequaert, 1925, p. 18, fig. 2.

"Type male from 'Baie du Geelvink, New Guinea' (Raffray and Maindron Coll., 1878). In the collection of the Paris Museum.

"A medium sized, robust, brown black species, covered with a dull, reddish brown tomentum; legs and antennae testaceous. Pilosity brownish grey on head and thorax; abdomen almost destitute of hairs. Wings long, deeply bisinuate along the posterior margin, deep reddish brown; an elongate and narrow hyaline streak in the fourth posterior cell and faint indications of hyaline in the centre of the combined first and second posterior and of the second basal cells.

"*Male.* Integument apparently black, though the body is so uniformly covered with tomentum that it is difficult to see the proper color. Antennae and legs pale testaceous; coxae more brownish; apical half of claws brownish black.

"Head and thorax with abundant, long, erect, brownish grey pilosity, which is denser on the ventral side. Hairs of the abdomen very short and sparse, dark grey; somewhat more abundant and longer ventrally and on the sides of the second tergite. Coxae and femora with moderately long, reddish grey hairs; the pilosity of tibiae and tarsi much shorter, but of the same color. Head, thorax, and abdomen are covered with a dull cinnamon red bloom. There are no traces of dull stripes on the thorax nor of spots on the abdomen; but the second tergite bears close to its base a deep, transverse groove, which is shiny except on the middle; in addition there is a short, transverse, shiny depression on the side of each of the tergites 2, 3, 4, and 5.

"Head large, much flattened, a little broader than the thorax; semielliptical in profile and from above; kidney-shaped and nearly twice as wide as high when seen in profile. Front narrowly triangular, widest at the antennae where it measures about one-half the width of the eye; the inner orbits strongly converging above, where they come extremely close together for a short distance below the anterior ocellus, though not actually touching. Vertex triangular. Ocellar protuberance quite prominent, short, deeply divided behind from the inner orbits which project a considerable distance beyond the occipital margin of the vertex. Ocelli large, of about the same size, placed in an equilateral triangle. Eyes bare, composed in their upper half of large facets which gradually merge into the much smaller ommatidia of the lower half. Antennae (Text-fig. 2, *a*) very small, placed a short distance from the inner orbits on the upper portion of the curved slope which leads into the deep transverse depression that separates the front from the face; basal segment short, much thicker than long, widened and crescent-shaped at the apex; second segment disk-shaped, almost circular from the side, as long as the first; third segment apparently fused with the style, the whole being over twice the length of the two basal segments together, extremely slender and narrow, strongly tapering from the basal third to the apex which is very sharply pointed. Front regularly curved from vertex to antennae, below which it droops deeply into a very pronounced transverse groove separating the face. Face sunken between the eyes, the median, shorter portion sharply divided from the lateral areas by deep, vertical grooves. Palpi and proboscis, if present, extremely reduced and not to be distinguished among the long pilosity. Body broad and thickset. Thorax about as thick as, but shorter than, wide; its dorsum distinctly convex. Transverse suture well marked on the sides, over less than one-third of the width of the dorsum, obliquely continued behind to a short distance from the scutellum. Scutellum large, nearly elliptical, its posterior margin not separated from the disk. Abdomen broad and short, but little longer than wide, quite convex dorsally and somewhat curved down at the apex. The several segments are distinctly constricted, their apical portion being slightly swollen. The first tergite is very short and mostly covered by the scutellum. Second tergite much the longest, about as long as the two following tergites together; in its basal half it is broadly grooved transversely, the bottom of the channel being shiny (except medially) and finely alutaceous; in addition there is on the posterior third of the tergite on each side a short, narrow and rather shallow, transverse groove, where the integument is also shiny and alutaceous. Third, fourth, and fifth tergites of about equal length, each on the sides, shortly behind the anterior margin, with a short, transverse shiny groove similar to that found on the hind third of the second tergite. The apical tergites are much shortened and somewhat retracted ventrally; they end in a prominent knob containing the large genitalia. Legs long and stout; the hind legs considerably longer than the anterior and middle pair. Fore and mid femora moderately and rather uniformly swollen, much thicker than the tibiae; hind femora elongate club-shaped, distinctly swollen toward the apex. Tibiae slender, not appreciably thickened at the apex. Tarsi short, narrower than the tibiae.

"Wings (Text-fig. 2, *b*) long and moderately wide, over three times as long as the greatest width, which lies at the apex of the anal cell. The fore margin quite straight; the hind margin wavy between the tip of the fifth longitudinal vein and the apex of the wing; of the two deep sinuations the proximal one, between the tips of the diagonal and fifth veins, is much the longest. Alula small, but quite well developed (as figured by Lichtwardt for *N. horni* and allies).

Epaulet and basicosta clove-brown. Wings of a deep brown, opaque color, with a distinct cinnamon-red tinge. A whitish hyaline, narrow, somewhat curved, longitudinal streak, with a pearly sheen, occupies the center of the fourth posterior cell (the cell immediately below the discal); it begins quite a distance from the base of the cell, where it is widest, and gradually tapers to a short distance from the diagonal vein. There are no other well marked hyaline spots; but the center of the combined first and second posterior and of the second basal cells is distinctly subhyaline and there is even a faint indication of a hyaline area in the second basal cell. The two wings are exactly alike in this respect. Veins bright reddish-brown, darker basally. Venation as in the other species of the genus; in detail it agrees best with Lichtwardt's figure of *N. kertészi* (*Entom. Mitteil.*, i, 1912, Pl. ii, fig. 2), but the short cross-vein which unites the first and second longitudinals is much further removed from the long cross-vein connecting the second and third longitudinals. It should also be noted that the auxiliary vein (or subcosta), which both Wandolleck and Lichtwardt figure as uniting with the first longitudinal about the middle of the wing, really continues its course independently to near the base, as in other Nemestrinidae; furthermore, it is connected, a short distance from the base, with the costa by a humeral cross-vein, apparently overlooked by these authors. The apex of the discal cell is far removed from the base of the combined first and second posterior cells. The costa extends to beyond the tip of the fourth longitudinal vein, whence it gradually fades away to the apex of the wing.

"Total length, 11 mm.; greatest width of abdomen, 5 mm.; length of wing, 13.5 mm.; greatest width of wing, 4 mm.

"The species is closely allied to *N. dohrni* and to *N. horni*, but differs conspicuously in the markings of the wing".

Unknown to me. These two species may be separated by the clear areas on the wings, *N. horni* Licht. having, in cell 1A, a large clear area which is concave anteriorly with a long sharp projection from its upper angle, and also two small clear spots in cell M. In *N. papuana* Beq. there is apparently no clear area in cell 1A and only an indication of one spot in cell M; there is also a clear area in cell M_3, which is not seen in *N. horni* Licht.

Genus Nycterimorpha Lichtwardt.

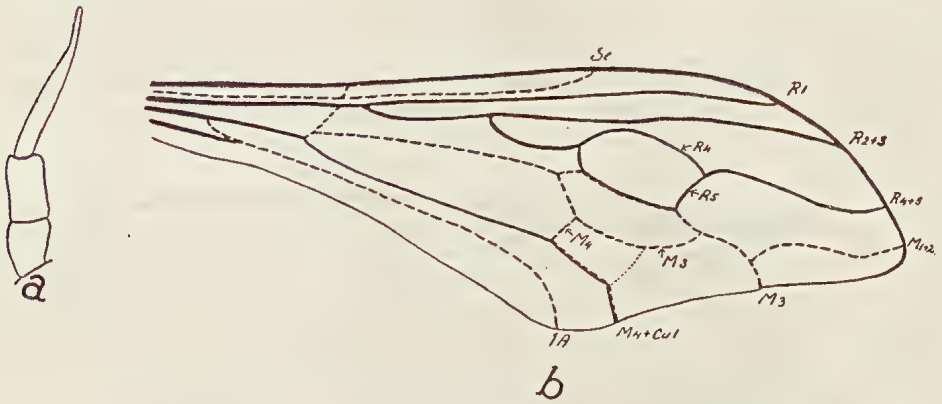
Lichtwardt, 1909, p. 648.—Hardy, 1924, p. 459, figs. 5 and 11.

Definition.—Eyes bare; ocelli present. Antennae with basal segments large and cylindrical, third segment merely part of the style. Proboscis not apparent, palpi conspicuous; face bare, deeply excavated. Legs incrassate. Wing very remarkable, hind angle absent and shape characteristic, R_4 and R_5 fused apically only, enclosing a small cell R_4, M_{1+2} overlapping R_5 markedly, M_1 and M_2 not separated, M_4 joined to Cu_1, a *c-v* present between M_3 and $M_4 + Cu_1$, limit of C not determined. Genitalia of male and female not described.

Genotype, *Nycterimorpha speiseri* Lichtwardt, 1909. Cairns.

This genus is very aberrant in body form and in the shape of the wing and in the venation. In the presence of a *c-v* between M_3 and M_4, in the disposition of M_4 and in the prominent palpi, there seems to be an indication of affinity with *Exeretoneura* Macq. but in other respects, and especially in the legs, the relationship to *Nycterimyia* Licht. is very close. The genus is certainly very peculiar and it is impossible to say any more without a careful study of actual specimens. The interpretation of the venation given in Text-fig. 16, *b* is purely tentative,

it being especially difficult to homologize the veins of such an unusual type in the absence of specimens.



Text-figure 16.—*Nycterimorpha speiseri* Licht.; *a*, antenna (after Hardy); *b*, wing (modified from Hardy and Lichtwardt).

NYCTERIMYIA SPEISERI Lichtwardt.

Lichtwardt, 1909, p. 648, fig. 6.—Hardy, 1924, p. 459, figs. 5 and 11.

"♂. Eine zierliche Fliege von etwa 6 mm. Länge, deren 8 mm. lange Flügel durch die schmale Basis noch länger erscheinen, als sie in Wirklichkeit sind. Das ganze Tier ist zart hellbraun gefärbt. Der Thorax, die Spitze der Hinterschenkel und die merkwürdig breiten, keulenförmigen Hinterschienen etwas dunkler. Auf der Mittellinie des Hinterleibes treten Spuren von dunkleren Fleckchen auf; besonders ist das Fleckchen auf dem zweiten Ringe deutlich, weil die Basis des Hinterleibes und das erste Drittel dieses Ringes schneeweiss gefärbt sind. Die Schwinger haben weisse Stiele und braune Köpfchen".

Unknown to me.

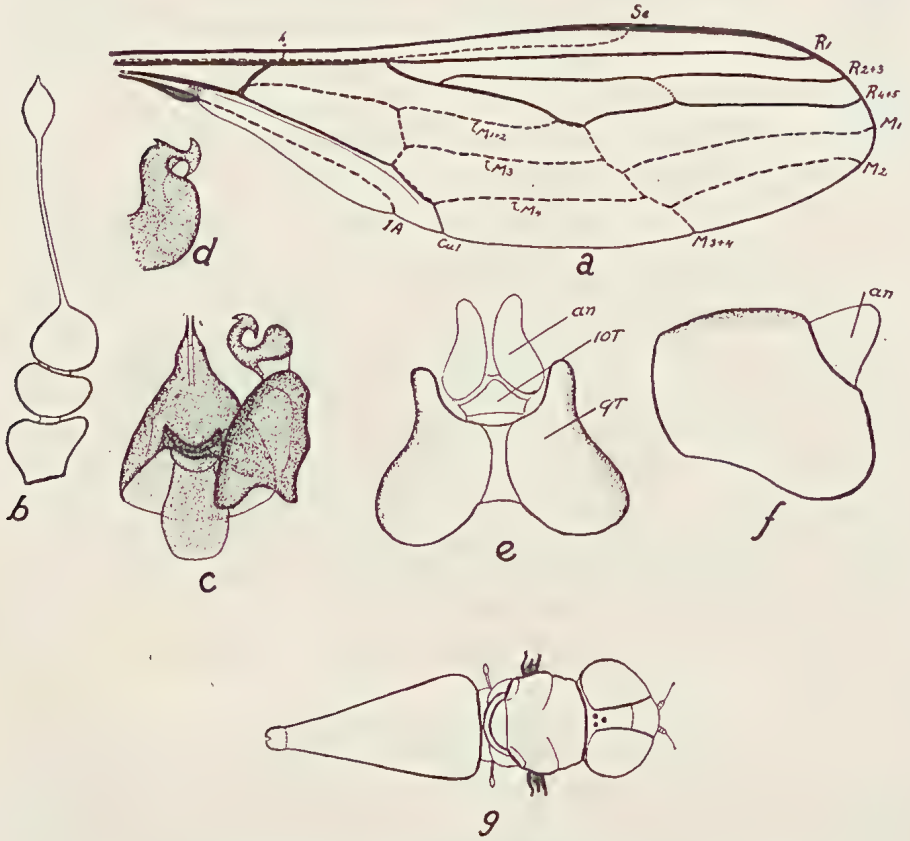
Distribution.—Queensland: Cairns (Lichtwardt); Tambourine Mt. (Hardy).

The Genus CYCLOPSIDEA, n. gen.

Definition.—Head large, rounded; thorax very small; abdomen elongate, tapering. Eyes large, subspherical, dichoptic in male, bare, facets small and of uniform size throughout; ocelli present. Proboscis visible, but very small and hardly projecting beyond the epistoma; palpi very small, conical. Antennae small, of three subequal segments and with a slender style, which appears to be continuous with the third segment and which bears apically a flattened leaf-like expansion. Wing with hind margin cut away and apex evenly rounded; C continuous all round wing margin, markedly thickened in its distal part anteriorly; R_{4+5} unforked, M_{1+2} overlapping R_{4+5} for a short distance, M_1 and M_2 separate distal to the oblique vein, M_4 fused with M_3 distally, M_4 fused with Cu_1 for a short distance thus eliminating *m-cu*; there is a *c-v* between R_{2+3} and R_{4+5}. Male genitalia prominent, with a large ninth tergite which is deeply excavated in the middle of its distal edge, ninth sternite large and continuous with the basistyles which are well developed, distostyle of complicated shape, basidistostyle absent; aedeagus forming a large bulb and short tube, elements fused together; tenth segment and anal lobes small, the latter membranous.

Genotype, *Cyclopsidea hardyi*, n. sp.

In the introduction I mentioned that Mr. Hardy had discovered a new genus. I have now to offer him my very grateful thanks for affording me the opportunity of examining and describing this very extraordinary fly. Superficially it resembles a Bombyliid of the genus *Geron*, or even more closely a Pipunculid, rather than a Nemestrinid. This peculiarity in body shape, which is shown in Text-figure 17, *g*, together with the small size and unusually shaped wings, is the most striking feature of this genus and, so far as I can determine,



Text-figure 17.—*Cyclopsidea hardyi*, n. sp.

a, wing; *b*, antenna, cleared preparation; *c*, dorsal view of parts underlying the ninth tergite; *d*, lateral view of distostyle; *e*, ninth and tenth tergites and anal lobes in dorsal view; *f*, lateral view of ninth tergite and anal lobes; *g*, dorsal view of body as a whole; 9T, ninth tergite; 10T, tenth tergite; *an*, anal lobe.

quite unique in the family. The mouth parts and antennae resemble those found in *Atriadops* Wand. and its allies, but the third antennal segment is not so reduced as in any of those genera; it is interesting to note that *Trichopsidea* Westw. shows the same expansion of the distal end of the style but in a much less developed condition. The venation is also closely similar to that of *Atriadops* Wand. and *Nycterimyia* Licht., while the absence of the hind angle is also seen in *Nycterimorpha* Licht., but the shape of the distal end of the wing, the con-

tinuous costa and the thickening of the costa anteriorly separate this genus widely from the others. The thickening of the costa and the absence of the hind angle of the wing approach the condition seen in *Stenobasipteron* Licht., but I feel confident that the resemblance is merely homoplastic, as in all other respects the species before me is quite unlike any placed in the African genus. Similarly, the absence of the hind angle cannot be taken as indicative of any close affinity with *Nycterimyia* Licht. On the other hand, the continuous costa and the rounded distal end of the wing, together with the slender body form, dichoptic eyes and the shape of the ninth tergite, basistyle and distostyle, might suggest relationship with *Exeretoneura* Macq., while the aedeagus, tenth segment and anal lobes are exactly like those of some species of *Trichophthalma* Westw. It must be remembered that many of these resemblances are due to the common possession of primitive features, which do not necessarily indicate *close* relationship, while the similarity in body and wing shape to *Exeretoneura* Macq., when analysed, is more apparent than real. The dichoptic eyes and the character of the ninth tergite and aedeagus must, however, be taken into consideration and these throw some doubt on the conclusions expressed below. Nevertheless I believe that the antennae, mouth parts and venation must for the present be accepted as of greater value and that this genus is more nearly related to the *Atriadops* series than to any of the others, but is much more primitive in most respects and diverged from the common stem at a very early stage of development. Consequently, the presumption is that its ancestors reached Australia from the Oriental Region. The character of the ovipositor of the female, when that sex is found, will probably be of great assistance, but the discovery of some form intermediate between this and some other known genus is necessary before any definite opinion can be expressed.

CYCLOPSIDEA HARDYI, n. sp.

A small slender species with rounded head. Dorsum dark brown, under surface grey. Legs partly grey, partly yellowish-brown. Wings short, glass clear.

♂. Eyes dark reddish-brown, large and rounded, separated by about one-sixth of the head width; ocelli forming an equilateral triangle, placed on a small eminence surrounded by a deep furrow. Frons dark brown, covered with short, stout, rather sparse black hairs; there is a shallow transverse groove, beneath which the frons bulges slightly, about one-third of the frons length above the antennae; face grey, covered with longer and denser white hairs; no beard. Antennae small and inconspicuous, dark brown in colour, basal two segments with short, sparse, inconspicuous creamy hairs. Mouth parts and palpi pale yellow, inconspicuous.

Scutum and scutellum dark brown, covered with brown to creamy hairs, which are longer and denser and form a creamy fringe at the sides of the scutum. Postscutellum bulging prominently. Pleurae grey, with sparse long creamy hairs. Legs with femora yellow at base and at the knee, remainder grey; tibiae yellowish-brown, rather darker distally, some grey dorsally on fore tibia; tarsi brown. Wings short, glass clear; costa thickened from a little proximal to the end of Sc nearly to the tip of the wing. Owing to the absence of the hind angle of the wing, the halteres, which are longer than usual, are very prominent.

Abdomen long and slender, tapering posteriorly, but with prominent genitalia. Above, it is dark brown in colour and covered with sparse, rather long, creamy hairs. Venter grey, with white hairs. Genitalia as in Text-figure 17, *c*, *d*, *e*, *f*. The ninth tergite and sternite are divided into two parts by a median longitudinal

zone which is less heavily chitinized than the rest. As well as the three hooks (dorsal and ventral distal, and a dorsal one on the neck) on the distostyle shown in Text-figure 17, *d*, there is another on the medial side at the distal end.

Length, body 5 mm., wing 4.7 mm.

Holotype, the unique male from Inglewood, Queensland, 1st September, 1925, in the collection of Mr. G. H. Hardy. Named after the collector in recognition of this and many other kindnesses.

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Photos. A. J. Nicholson.

1, 2. *Trichophthalma rosea* Macq. 3. *T. albimacula* Walk.
4. *T. primitiva* Walk.

VICTORIA
NATIONAL MUSEUM

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* I have not seen these papers, the references being taken from Mr. Hardy's paper.

EXPLANATION OF PLATE L.

1, *Trichophthalma rosea* Macq., ♂, feeding on *Epacris microphylla*; 2, *T. rosea* Macq. ♀, on *Leptospermum* sp.; 3, *T. albimacula* Walk., ♂, on *E. microphylla*; 4, *T. primitiva* Walk., ♂, on *E. microphylla*. Photographs natural size from life.—A. J. Nicholson.

Addendum.

Mr. G. H. Hardy has asked me to call attention to and to correct the following errors in his paper on this family (PROC. LINN. SOC. N.S.W. xlix, 1924, 448-460):—

p. 451, line 12—for *variosa*, read *variolosa*
p. 451, line 26—for *albitarsis*, read *albibasis*
p. 454, line 14—for *montanea*, read *monotaenia*
p. 455, line 45—for *richardoae*, read *ricardoae*
p. 456, line 15 and p. 448, line 48—for *Atriatops*, read *Atriadops*

ABSTRACT OF PROCEEDINGS.

ORDINARY MONTHLY MEETING.
29th April, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

The Donations and Exchanges received since the previous Monthly Meeting (26th November, 1924) amounting to 61 Vols., 305 Parts or Nos., 32 Bulletins, 11 Reports and 2 Pamphlets, received from 137 Societies and Institutions and 7 private donors were laid upon the table.

PAPERS READ.

1. The Loranthaceae of Australia. Part vi. By W. F. Blakely.

2. Geology and Petrography of the Clarencetown-Paterson District. Part iii. A study of the Main Glacial Beds at Seaham. By G. D. Osborne, B.Sc.

3. Notes on the Occurrence of Glendonites and Glacial Erratics in Upper Marine Beds at Ulladulla, N.S.W. By Ida A. Brown, B.Sc.

4. On a Remarkable Modification of the Eighth Abdominal Segment in *Lindera tessalatella* Blanch. with a description of the male and female genitalia. By A. Philpott. (*Communicated by Mr. E. C. Andrews.*)

ORDINARY MONTHLY MEETING.
25th March, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

Dr. C. H. Burton Bradley, 211 Macquarie Street, Sydney; Messrs. G. H. Cunningham, Department of Agriculture, Wellington, New Zealand; W. A. W. de Beuzeville, Tumut, N.S.W.; H. M. Hale, South Australian Museum, Adelaide, South Australia; W. Q. Harris, Lane Cove Road, St. Leonards; Frank A. McNeill, Australian Museum, Sydney; E. F. Northcroft, Wellington, New Zealand; and W. M. Steinbeck, 1 Curry Street, Merewether, N.S.W., were elected Ordinary Members of the Society.

The President announced that the Council had elected Professor H. G. Chapman, M.D., B.S., Mr. J. J. Fletcher, M.A., B.Sc., Dr. G. A. Waterhouse, B.E., F.E.S., and Mr. R. H. Cambage, F.L.S., to be Vice-Presidents, and Mr. J. H. Campbell, M.B.E., to be Hon. Treasurer for the current session, 1925-26. The President also announced that Mr. E. Cheel had been elected a member of Council in place of the late Professor Haswell.

The Donations and Exchanges received since the previous Monthly Meeting (25th March, 1925), amounting to 6 Vols., 107 Parts or Nos., 7 Bulletins and 7 Reports, received from 54 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. Australian Mydaidae (Diptera). By G. H. Hardy.

2. Notes on Australian Diptera. No. v. By J. R. Malloch. (*Communicated by Dr. E. W. Ferguson.*)

3. A Few Observations on the Geology and Geography of North-west and Desert Basins, Western Australia. By Frederick G. Clapp (*Communicated by Professor Sir T. W. E. David.*)

4. An Ecological Study of the Flora of Mount Wilson, Part ii. The Eucalyptus Forests. By Arthur H. K. Petrie.

NOTES AND EXHIBITS.

Mr. D. G. Stead exhibited the skull of a Green Turtle (Malay *Penyu*) taken by him from a turtle at Great Redang Island, lying off the coast of the Malay State of Trengganu in the China Sea in May, 1922. He described the method followed by this species of turtle, both in making the pits or "nests," and in oviposition. A great conical excavation, about three feet in depth, is first made by the turtle, and then a vertical cylindrical one about 18 inches deep by 15 inches wide, into which the eggs are dropped in rapid succession. About 130 to 150 eggs are laid at one sitting. Until the digging process is well advanced the turtle is very shy and, when disturbed, will hurry off to the water; but when the cylindrical hole has been started nothing will frighten the reptile. From one adult female which had just started excavating, 144 eggs ready for immediate extrusion, as well as 564 smaller ones in varying stages of development, were taken. Immense numbers of eggs are taken by a huge Monitor Lizard, *Varanus* (Malay *Biawak*).

Mr. W. W. Froggatt exhibited *Penthea picta* Pascoe. Specimens were bred out in March, 1923, from specimens of saltbush which was dying out in patches at Coonamble at the time. There were numbers of active larvae in the remaining roots which were left in a closed tin until April, 1924, when three larvae were found still living in the dry roots. They were dipped in water and replaced in the tin where they were kept till January, 1925, when one larva still lived. This was removed to a test-tube and pupated in the middle of February, remaining in the pupal state for 14 days. The beetle, still alive (29/4/1925), was exhibited.

Mr. Froggatt also exhibited a longicorn, *Scolecobrotus westwoodi* Hope, which emerged from the pupal stage in the stem of an Ironbark from Forbes about the middle of June, 1924, and remained a soft, immature beetle in the bore until the end of the year. It was taken out and placed in a test-tube where it had just attained its natural colour.

Mr. N. B. Friend exhibited stalactites collected in a cave at National Park. The cave is in sandstone and contains a large number of stalactites, the larger ones being about eight feet long, and reaching from floor to roof.

Mr. J. R. Kinghorn exhibited a drawing of a specimen of *Pletholax gracilis* Cope, a very slender legless lizard, which was originally described about 60 years ago, but of which no specimen other than the original one had been discovered till quite recently. The specimen, of which the drawing was exhibited, was forwarded from the Western Australian Museum and had been obtained from the same locality as the original example.

Mr. M. B. Welch exhibited a specimen of the wood of *Eucalyptus saligna* grown in Transvaal, from a tree 12 years old and 16 inches in diameter at the time of falling. The oven-dry weight is 27 lbs. per cubic foot in comparison with 46-56

lbs. per cubic foot for timber of the same species grown under natural forest conditions in New South Wales and Queensland. It has recently been suggested in South Africa that *E. saligna* might help to furnish a part of that country's softwood requirements.

ORDINARY MONTHLY MEETING.

27th MAY, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

The President, on behalf of members, offered congratulations to Mr. C. Hedley (in absentia) on the award to him of the Clarke Medal by the Royal Society of New South Wales; also to Miss May M. Williams on attaining the degree of Master of Science in the University of Sydney.

The Donations and Exchanges received since the previous Monthly Meeting (29th April, 1925), amounting to 11 Vols., 89 Parts or Nos., 4 Bulletins and 7 Reports, received from 60 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. Contribution to the Cytology and Phylogeny of the Siphonaceous Algae. i. The Cytology of the Gametangia of *Codium tomentosum*. By May M. Williams, B.Sc., Linnean Macleay Fellow in Botany.

2. Burrowing Habits of *Ornithorhynchus*. By H. Burrell, C.M.Z.S.

3. Notes on Australian Diptera. No. vi. By J. R. Malloch. (*Communicated by Dr. E. W. Ferguson.*)

4. Geology and Petrography of the Clarencetown-Paterson District. Part iv. By G. D. Osborne, B.Sc., Linnean Macleay Fellow in Geology.

NOTES AND EXHIBITS.

Mr. A. F. Basset Hull exhibited 40 examples of abnormal Loricates, having less than the normal eight valves. Twenty species were represented, and there were specimens having five, six, or seven valves. Several examples showing injury and repair were also exhibited.

Mr. W. W. Froggatt exhibited a collection of insects obtained in the Pilliga Scrub and made some remarks upon the dry pine forest insect fauna in December and January. In December the eastern side between Narrabri and Wee Waa, and in January the district from Baradine to Pilliga was visited, the time of collecting being about eight days.

Mr. N. B. Friend furnished an analysis of a stalactite from a cave at National Park, specimens of which were exhibited at the last monthly meeting. The analysis, made by Mr. W. M. Doherty, F.C.S., F.I.C., of the Department of Public Health, is as follows:—Organic matter 0·80%, Silica 3·20%, Iron oxide 0·07%, Alumina 0·03%, Calcium carbonate 91·43%, Magnesium carbonate 4·24%, Moisture, Loss, Trace of Manganese, etc., 0·23%.

ORDINARY MONTHLY MEETING.

24th JUNE, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

Mr. Theodore Cleveland Roughley, Economic Zoologist, Technological Museum, Sydney, was elected an Ordinary Member of the Society.

The President offered the congratulations of members to Mr. R. H. Cambage, C.B.E., on the honour conferred on him by His Majesty the King. The President

also congratulated Mr. D. G. Stead on his appointment as a Commissioner to inquire into the numerous aspects of the Rabbit Pest in the State.

The President announced that Mr. T. Steel, who had been a member of Council since 1897, had resigned from the Council on account of ill health.

The Donations and Exchanges received since the previous Monthly Meeting (27th May, 1925), amounting to 25 Vols., 131 Parts or Nos., 25 Bulletins and 7 Reports, received from 70 Societies and Institutions and 3 private donors were laid upon the table.

PAPERS READ.

1. The Australian species of *Oncopera* (Hepialidae, Lepidoptera). By John R. Eyer and A. J. Turner, M.D., F.E.S.

2. Fossil Plants from the Narrabeen Stage of the Hawkesbury Series. By A. B. Walkom, D.Sc.

3. New Genera and Species (mostly Australasian) of Blattidae, with Notes, and some Remarks on Tepper's Types. By A. Eland Shaw, M.R.C.S., F.E.S.

NOTES AND EXHIBITS.

Mr. G. D. Osborne exhibited silicified specimens of a Zygopterid stem found about 2,000 feet above the base of the Kuttung Series (Carboniferous), nearly four miles NNE. of Mt. Tangorin. A specimen of the same material, collected by Dr. Walkom in 1912, has been described as *Clepsydropsis australis* by Sahni (*Ann. Bot.*, 1919), who considered it to be specifically identical with another Zygopterid stem found further north by Professor Benson.

Mr. E. Cheel exhibited seedling plants of *Eucalyptus ficifolia* and *E. calophylla* var. *rosea* raised from seed obtained from trees in the Melbourne Botanic Gardens and Western Australia, and from a tree in Belmore Park, near the Hotel Sydney, respectively, showing no development of a peltate character in the leaves as has been recorded for the species.

Mr. W. W. Froggatt exhibited specimens showing the damage caused to timber and furniture by the European Furniture Beetle, *Anobium punctatum*. This beetle is the most destructive timber pest known, as the perfectly seasoned timber is attacked, and is never safe. New Zealand White Pine (*Podocarpus dacrydioides*) is one of the worst timbers for spreading this beetle in New South Wales. This is so well known in New Zealand that it is not used in constructional work in that country, yet last year 24,711,900 feet were imported into New South Wales.

He also exhibited specimens of the large Click Beetle (*Alaus prosectus* Cast.) and its larva which is the chief destroyer of longicorn larvae under the bark of dead hoop pines in the Dorrigo Forest.

Dr. Chisholm exhibited a specimen of Vegetable Caterpillar (*Cordyceps* sp.) from the Comboyne Plateau; also an etiolated specimen of the Arum Lily.

Mr. D. G. Stead exhibited two photographs, taken from the air, showing Kealakekua Bay on the southern side of the island of Hawaii, and the monument erected on the spot where Captain Cook was killed.

ORDINARY MONTHLY MEETING.

29th JULY, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

Miss Enid Mitchell, Women's College, St. Paul's Road, Newtown, and Mr. Ivor Vickery Newman, Kingsland Road, Strathfield, were elected Ordinary Members of the Society.

The President announced that Mr. G. M. Goldfinch had been elected a Member of Council in place of Mr. T. Steel.

The Donations and Exchanges received since the previous Monthly Meeting (24th June, 1925), amounting to 11 Vols., 110 Parts or Nos., 6 Bulletins and 2 Pamphlets, received from 56 Societies and Institutions and 4 private donors were laid upon the table.

PAPERS READ.

1. Revision of the Australian Species of *Chrysobothris* (Buprestidae), together with Notes, and Descriptions of New Species of Coleoptera. By H. J. Carter, B.A., F.E.S.

2. Two New Species of *Callistemon*, with Notes on Certain Other Species. By E. Cheel.

3. Gasteromycetes of Australasia. ii. A revision of the Genus *Tulostoma*. By G. H. Cunningham.

NOTES AND EXHIBITS.

Mr. Walter W. Froggatt exhibited a drawing by Miss King of the life history of the Leaf Mining Moth *Acrocercops plebeia* Turner. The larvae of this moth are seriously defoliating the Queensland Silver Wattle (*Acacia podalyriaefolia*), which has been so largely planted in gardens during the last few years. Until the last two years the bushes were perfect, but in many gardens about Sydney and Melbourne this moth is now damaging all the foliage, each leaf being marked with a brown blister, caused by the slender green or pink larva feeding under the epidermis. When full fed the larvae leave the leaf and form a little semi-transparent brown scale in which they pupate. Many moths emerged in January in the exhibitor's breeding cages. Dr. A. Jefferis Turner, who identified the specimens, says, though he described this moth from Brisbane specimens in 1894, it is comparatively rare in Queensland and he had never previously seen specimens from New South Wales. He suggests that this moth has some effective parasite in Queensland, and that the moth has been accidentally introduced with wattle flowers and foliage from Queensland, into this State, without the control parasite.

Mr. W. L. Wearne exhibited a specimen of island timber, which is being imported to take the place of Queensland maple, to show the effect of the work of the pinhole borer.

Miss V. Irwin Smith exhibited a Mydaid fly larva, *Diochlistus gracilis*, which had maintained its vitality under very adverse conditions, having lived for twelve months in a small pill bottle in about half an ounce of perfectly dry sand, without food for at least eight months, and with only one or two drops of water on seven occasions at intervals of from four to ten weeks. In this condition it had survived a journey to England by ordinary packet post, and on its return to Australia after twelve months was still perfectly healthy and active.

ORDINARY MONTHLY MEETING.

26th AUGUST, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

Professor Horace Hugh Corbin, University of Adelaide, S.A., and Mr. Colin Barnard, "Brogo," Baillie Street, Huntley's Point, Sydney, were elected Ordinary Members of the Society.

The President referred to the death of Mr. T. Steel who had been a member of the Society since 1886 and a member of Council from 1897-1925. A letter was

received from Mrs. Steel and family returning thanks for the sympathy of members of the Society with them in their loss.

The Donations and Exchanges received since the previous Monthly Meeting (29th July, 1925), amounting to 10 Vols., 89 Parts or Nos., 15 Bulletins, 3 Reports and 2 Pamphlets, received from 55 Societies and Institutions and 3 private donors were laid upon the table.

PAPERS READ.

1. The Comboyne Plateau: its General Conformation and Flora. By E. C. Chisholm, M.B., Ch.M.

2. A Comparison of the Male Genitalia of the Palaeosetidae with those of Other Lepidoptera Homoneura. By John R. Eyer (*Communicated by Dr. A. J. Turner.*)

3. Notes on Species of *Pterostylis*. By Rev. H. M. R. Rupp, B.A. (*Communicated by Mr. E. Cheel.*)

4. On the Tachinid Genus *Euthera*, with Descriptions of New Species from Australia, Africa and South America. By Professor M. Bezzi. (*Communicated by Dr. E. W. Ferguson.*)

NOTES AND EXHIBITS.

Mr. E. Cheel exhibited a flowering specimen of *Hicksbeachia pinnatifolia* (Family Proteaceae) taken from a plant cultivated at Ashfield. The plant was raised from a seed collected at Murwillumbah in September, 1917, and is now seven feet high and has nineteen racemes of flowers almost fully developed, the racemes being about eight inches long. There are thirty-two other racemes of flowers in various stages of development on the same plant. The plant bears a thin-shelled nut, the edible qualities of which are fairly good. If a cross could be effected between this and the closely related *Macadamia ternifolia*, it may be possible to obtain some interesting hybrids with thinner shells than those of the latter.

Mr. W. L. Wearne exhibited sap-wood of Red Cedar (*Cedrela Toona*) damaged by the Powder Post Borer (*Lyctus* sp.) together with the larvae and pupae of the borer, and also a type of parasitic insect. The timber was sawn in a green condition in November, 1924, and flight holes were first observed in April, 1925, when the moisture content of the wood was 16·5%. This proves that infestation must have occurred whilst the moisture content was much higher than would occur in seasoned timber.

Mr. John Mitchell exhibited an interesting series of pebbles showing a kernel inside a hard ferruginous shell, and faulting and folding on a small scale; also a waterworn pebble pierced by a smaller and harder pebble. He also exhibited a glaciated pebble from the debris resulting from the breaking down of the conglomerate at Tick Hole (Cardiff), near Newcastle; the occurrence of this pebble in the conglomerate belonging to the Newcastle Coal Measures is of interest, but only indicates that the glaciation took place before the deposition of these coal measures.

He also exhibited a piece of timber, taken from a large tree (*Eucalyptus* sp.) from the Tick Hole brush, which bears the toe-hold made with a stone axe by an aboriginal to facilitate his ascent of the tree. This piece of timber was eight inches in from the surface of the tree when felled and the exhibitor calculated that in the wood exhibited there were thirty-eight annual rings to the inch, which, added to the time taken for the wound to heal, would make the age of

the toe-hold well over three hundred years, i.e. some two hundred years before the advent of white man to Australia.

ORDINARY MONTHLY MEETING.

30th SEPTEMBER, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

The President referred to the deaths of Mr. W. L. May, who had been a member of the Society since 1902, and of Mr. A. R. McCulloch, who had been a member of the Society since 1907 and a member of Council since 1924.

The President announced that the Council was prepared to receive applications for four Linnean Macleay Fellowships tenable for one year from 1st March, 1926, from qualified candidates. Applications should be lodged with the Secretary, who would afford all necessary information to intending candidates, not later than Wednesday, 4th November, 1925.

The President also announced that Mr. A. F. Basset Hull had been elected a member of Council to fill the vacancy caused by the death of Mr. A. R. McCulloch.

The attention of members was called to the Australian Wild Flower, Natural History and Aquarium Exhibition to be held in the Art Gallery of the Education Department from 8th to 14th October, 1925.

The Donations and Exchanges received since the previous Monthly Meeting (26th August, 1925), amounting to 13 Vols., 111 Parts or Nos., 14 Bulletins and 3 reports, received from 59 Societies and Institutions and 5 private donors were laid upon the table.

PAPERS READ.

1. A New Fossil Insect Wing from Triassic Beds near Deewhy, N.S.W. By R. J. Tillyard, M.A., D.Sc., F.R.S.

2. Notes on Australian Diptera. No. vii. By J. R. Malloch. (*Communicated by Dr. E. W. Ferguson.*)

3. The Haematozoa of Australian Marine Teleostei. By I. M. Mackerras, B.Sc., M.B., Ch.M., Linnean Macleay Fellow of the Society in Zoology, and M. J. Mackerras, B.Sc., M.B.

4. Gasteromycetes of Australasia. iii. The genera *Bovista* and *Bovistella*. By G. H. Cunningham.

5. The Influence of Certain Colloids upon Fermentation. Part ii. By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.

NOTES AND EXHIBITS.

Mr. A. F. Basset Hull, in May last, exhibited specimens of abnormal Loricates having 5, 6 or 7 valves, and referred to the existence of one example in the British Museum having three valves only, and stated that no examples having four, or more than eight valves had been recorded. He has since discovered two specimens having nine valves, the species being *Amphitomura gemmata* Blainville, and *Onithochiton quercinus* Gould, both collected in Queensland waters.

He also exhibited a series of *Rhyssoplax discolor* Souverbie, which he recently collected in New Caledonia, showing the normal brownish shells, the brilliant vermilion variety named *Chiton miniaceus* by Carpenter, and numerous other colour variations.

Mr. W. W. Froggatt exhibited (1) beetle galls upon the base of the stems of coppice growing iron barks (*Eucalyptus siderophloia*) from Limeburner's Creek, Clarencetown, N.S.W. A considerable area of these young trees has been

attacked by some undetermined weevil. The larvae feeding beneath the bark in circular pits in the wood produce large gouty growths of aborted wood, each woody mass containing a large number of rounded, small-headed yellow larvae; (2) flower bud galls produced by a phytophagous wasp (*Trichilogaster acaciae-longifoliae* Frogg.) originally described from galls on *Acacia longifolia* at Rose Bay. A specimen of *Acacia floribunda* brought from the northern rivers as a tiny seedling, now a large tree growing in his garden at Croydon, has been more or less infested with these galls for the last two years. This year every flower bud or embryo seed-pod has been aborted into a gall, and there is not a single seed-pod on the tree.

Mr. W. Welch exhibited a Sinhalese Water-Clock, probably more than two hundred years old, consisting of a bowl about four inches across with a small hole at the pole of the hemisphere. The bowl is floated in a basin of water and will fill and sink in exactly twenty-four minutes (the Sinhalese hour) if properly constructed. Mr. Welch stated that the example exhibited sinks regularly within a few seconds of twenty-four minutes.

ORDINARY MONTHLY MEETING.

28th October, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

Candidates for Linnean Macleay Fellowships, 1926-27, were reminded that Wednesday, 4th November, 1925, was the last day for receiving applications.

The Donations and Exchanges received since the previous Monthly Meeting (30th September, 1925), amounting to 17 Vols., 54 Parts or Nos., 8 Bulletins and 2 Reports, received from 43 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. Notes on Australian Coccidae with Descriptions of New Species. By W W. Froggatt, F.L.S.

2. The Anatomy of *Lindsaya linearis* and *L. microphylla*. By May M. Williams, M.Sc., Linnean Macleay Fellow of the Society in Botany.

3. Descriptions of New Species of Australian Coleoptera. Part xviii. By A. M. Lea, F.E.S.

4. Contributions to our Knowledge of the Flora of New South Wales. By W. F. Blakely.

5. Two New Species of Silky Lacewings (Fam. Psychopsidae, Order Neuroptera Planipennia) from Australia. By R. J. Tillyard, M.A., D.Sc., F.R.S.

6. A Note on an unusual Type of Secreting Epithelium in the Wolffian Duct of the Dog-fish (*Scylliorhinus canicula*). By P. D. F. Murray, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

NOTES AND EXHIBITS.

Mr. J. J. Fletcher gave some details of the life of Charles Gould, a son of John Gould, and one of the pioneers of geology in Tasmania, of whom a brief biographical sketch was published in 1899 (*Quart. Journ. Geol. Soc. London*).

Mr. A. J. Nicholson exhibited a series of photographs illustrating the extraordinary wasp-like attitudes assumed by a species of *Microdon* (Diptera, fam. Syrphidae); also a living and a pinned specimen of the same species, and a larva and photograph of same. In addition, pinned specimens of two other species of

Microdon, one wasp-like and the other of normal dipterous form, except for the antennae which are of very abnormal form. The wasp-like form was found flying near the ground amongst grass in exactly the same situation as a Eumenid which was common at the time and for which it was at first mistaken. A specimen of the Eumenid was also exhibited.

Mr. Harry Burrell contributed some field observations of the way in which a female copper-headed snake (*Denisonia superba*) manoeuvred to close the aperture of its hole after entering. This result was achieved by drawing into position with its tail a piece of dried cattle manure which efficiently covered the hole. Mr. Burrell observed the lid on three consecutive days, finding it in position over the hole when the snake was inside, and alongside the hole when the snake was out. He exhibited photographs of the entrance with the lid in position and also with the lid off.

Mr. David G. Stead exhibited the leaf of a Moreton Bay Fig, *Ficus macrophylla*, taken from a tree at Cobar, in a region having a mean annual rainfall of only 13 inches. The tree in question had passed through the great drought of 1902.

Mr. Stead also spoke of some of his recent journeys in inland New South Wales and referred (1) to the widespread occurrence of the common pie melon over thousands of square miles of country in the central and western divisions; and (2) to the fact that camels had firmly established themselves in a wild state in the country a little to the north-west of Bourke, where they subsisted primarily upon the indigenous scrub.

Mr. E. Le G. Troughton exhibited (by permission of the Director of the Australian Museum) the skull of an adult female aboriginal from Normanton, Queensland, which is one of the "Roth Collection" (No. E. 15228 in the museum collection). The specimen greatly impressed Dr. Hrdlicka, of the Smithsonian Institution of Washington. Apparently the cranium had received a violent blow with a sharp instrument, completely severing a large piece of bone, portion of which subsequently became reunited. A remarkable feature is that the individual sustaining the extensive injury apparently survived for a considerable time, though a large fragment of bone had been removed exposing the brain cavity, and that despite the violent rupture and displacement of the controlling membrane or periosteum there had been no marked formation of callus, healing having apparently taken place without suppuration.

Mr. C. Hedley gave a short account of some recent work on the Great Barrier Reef, and it was decided that a meeting of the Society in the near future be devoted to a discussion on this interesting subject.

ORDINARY MONTHLY MEETING,
25th November, 1925.

Mr. H. J. Carter, B.A., F.E.S., President, in the Chair.

The President referred to the death of Mr. J. H. Maiden, F.R.S., who had been a member of the Society since 1883, a member of Council from 1887 to 1922. Members expressed their sympathy with Mrs. Maiden and daughters by standing in silence.

Professor T. Griffith Taylor, Professor of Geography, the University of Sydney, Mr. Edward J. Dumigan, Bald Hills, via Brisbane, Q., and Miss Hazel C. Weekes, Vivian Street, Bellevue Hill, were elected ordinary members of the Society.

The President announced that the Council had re-appointed Mr. P. D. F. Murray, Miss May M. Williams, Dr. I. M. Mackerras and Mr. G. D. Osborne to Linnean Macleay Fellowships in Zoology, Botany, Zoology and Geology respectively for one year from 1st March, 1926.

The President offered congratulations on behalf of members to Professor A. N. Burkitt on his appointment to the Chair of Anatomy in the University of Sydney.

The Donations and Exchanges received since the previous Monthly Meeting (28th October, 1925), amounting to 7 Vols., 85 Parts or Nos., 5 Bulletins, 3 Reports and 2 Pamphlets, received from 45 Societies and Institutions and 2 private donors were laid upon the table.

PAPERS READ.

1. The Labial Palpi of *Trichophysetis cretacea* and *Argyria amoenalis*. By A. Philpott. (*Communicated by Dr. A. J. Turner.*)

2. Descriptions of New Species of *Leaia*. By John Mitchell.

3. The Development of two Australian Sponge-Crabs. By H. M. Hale.

4. Geology of the Milton District. By Ida A. Brown, B.Sc.

5. The Nemestrinidae (Diptera) of the Australasian Region. By I. M. Mackerras, B.Sc., M.B., Ch.M., Linnean Macleay Fellow of the Society in Zoology.

6. Description of a New Species of Mycetophilidae (Diptera) with Luminous Larvae. By E. W. Ferguson, M.B., Ch.M.

7. On the Occurrence of Placentation in the Scincid Lizard, *Lygosoma entrecasteauxi*. By Professor L. Harrison, B.A., B.Sc., and Hazel C. Weekes.

8. The Salinity of Inshore Oceanic Waters of Australasia in relation to Fishes. By W. J. Phillipps, F.L.S., and F. J. T. Grigg, M.Sc. (*Communicated by Professor H. G. Chapman.*)

NOTES AND EXHIBITS.

Mr. David G. Stead exhibited on behalf of Mr. W. H. Wailes, seven very distinct types of the common Golden Carp, *Carassius auratus* (Linn.), which had been bred from one female "scaleless telescope" variety (red-gold colour), having the "fan" tail, and two males—one of which was a "scaled telescope" (bronze colour), and one "scaleless white" fantail. There were about 200 progeny hatched from the one batch of eggs, comprising (*a*) about 40 ordinary silver or bronze carp; (*b*) a miscellaneous assortment of fantails, "comets", "telescopes", "scaleless", etc.

Mr. John Mitchell exhibited (1) a fragment of the skeleton of a fossil fish embedded in a piece of diatomaceous earth, from Bugaldi, near Coonabarabran, N. S. Wales. (2) A valve of a fossil pelecypod (?), found some three years ago in a bed of fine tuff (chert) outcropping along the lake shore at Warner's Bay, Lake Macquarie, associated with *Leaia*, *Estheria*, and fossil insect remains. The geological horizon of the rock in which it was found is estimated to be identical with that of the Belmont fossil insect Beds, and of Upper Permian age; and, if the assumption of its pelecypodous nature proves to be correct, it will be, as far as the exhibitor is aware, the first of its kind recorded from the Newcastle Coal Measures. (3) A specimen of *Eurydesma cordatum* var. *sacculum* Dana showing the muscular scars very distinctly. (4) The fragmentary counterpart of a fairly large hind wing of a fossil Scorpion fly, said by Dr. Tillyard to be the largest of its kind yet found in the Belmont Beds.

Mr. E. Le G. Troughton exhibited (by permission of the Director of the Australian Museum) a mounted specimen of *Caenolestes fuliginosa* from Ecuador, representative of the only living family of diprotodont marsupials occurring outside Australasia; the other family of living marsupials found in Central and South America being the true opossums (Didelphiidae) which are polyprotodonts.

DONATIONS AND EXCHANGES.

Received during the period 27th November, 1924, to 25th November, 1925.

(From the respective Societies, etc., unless otherwise mentioned.)

ABERYSTWYTH.

Welsh Plant Breeding Station, University College of Wales,—Bulletins, Series C, 1, 3 (1921, 1923); Series H, 2-4 (1924-1925).

ACCRA.

Government of the Gold Coast.—"Outline of the Mineral Resources of the Gold Coast with Hints on Prospecting", by A. E. Kitson (1925); Report of the Geological Survey for the Period 1st January, 1922, to 31st March, 1923 (1924).

ADELAIDE.

Australasian Antarctic Expedition, 1911-1914.—Scientific Reports, Series B, i, 1-2; ii, 1 (1925).

Department of Mines: Geological Survey of South Australia.—Annual Report of the Director of Mines and Government Geologist for 1917 (1918); 1923 (1924); 1924 (1925); Bulletin No. 11 (1925); Mining Review for Half Years ended June 30th, 1924 (No. 40) (1924); December 31st, 1924 (No. 41) (1925).

Field Naturalists' Section of the Royal Society of South Australia.—"The South Australian Naturalist", vi, 1-4 (1924-1925).

Public Library, Museum, and Art Gallery of South Australia.—Records of the S.A. Museum, iii, 1 (1925); Report of the Board of Governors for 1924-25 (1925).

Royal Geographical Society of Australasia, South Australian Branch.—Proceedings, xxv, Session 1923-24 (1925).

Royal Society of South Australia.—Transactions and Proceedings, xlviii (1924).

South Australian Ornithological Association.—"The South Australian Ornithologist", viii, 1-4 (1925).

University of Adelaide.—"The Australian Journal of Experimental Biology and Medical Science", i, 4 (T.p. & c.) (1924); ii, 1-3 (1925).

Woods and Forests Department.—Annual Progress Report for the Year 1923-24 (1924).

ALGER.

Institut Pasteur d'Algérie.—Archives, ii, 1-4 (T.p. & c.) (1924).

AMSTERDAM.

Nederlandsche Entomologische Vereeniging.—Entomologische Berichten, vi, 125 (1922); 138-143 (1924-1925); Tijdschrift voor Entomologie, lxvii and Supplement, 1924 (T.p. & c.) (1924).

ANN ARBOR.

University of Michigan.—Contributions from the Museum of Geology, i (bound, complete); ii, 1-3 (1924); Miscellaneous Publications of the Museum of Zoology, Nos. 12-14 (1924); Occasional Papers of the Museum of Zoology, Nos. 144-152 (1923-1924); Papers of the Michigan Academy of Science, Arts and Letters, iv, 1-2, 1924 (1925).

AUCKLAND.

Auckland Institute and Museum.—Annual Reports, 1916-17 (1917); 1917-18 (1918); 1924-25 (1925).

BALTIMORE.

Johns Hopkins University.—University Circulars, N.S. 1924, 1-6 (1924).

BARCELONA.

Real Academia de Ciencias y Artes de Barcelona.—Boletin, v, 2 (1925); Memorias, xviii, 10-23 (T.p. & c.) (1924-1925); xix, 1-7 (1924-1925); Nomina del Personal Academico, 1924-1925 (1925).

BASEL.

Naturforschende Gesellschaft.—Verhandlungen, xxxiv, 1922-23 (1923); xxxv, 1-2, 1923-24 (1923-1924).

BATAVIA.

Koninklijke Natuurkundige Vereeniging in Nederl.-Indië.—Natuurkundig Tijdschrift voor Nederlandsch-Indië, lxxxiv, 3 (T.p. & c.) (1924); lxxxv, 1 (1925).

BERGEN.

Bergens Museum.—Aarbok, 1922-23, 2 (T.p. & c.) (1924); 1923-24, 1-2 (T.p. & c.) (1924-1925); Aarsberetning, 1923-24 (T.p. & c.) (1924-1925); "Bergens Museum 1925" (1925).

BERKELEY.

University of California.—Publications: Botany, T.p. & c. for vii (1924); T.p. & c. for viii, 1-2 (1919-1920); viii, 3 (1925); x, 8 (1924); xi, 2 (1925); xiii, 1-4 (1924-1925); Entomology, iii, 3-4 (1925); Geology, Index to x; T.p. & c. for xix, 1922-1923; xv, 4-11 (1925); Zoology, xxvi, 16-24 (1924-1925); xxvii (1925).

BERLIN.

Botanisches Gartens und Museums.—Notizblatt, ix, 82-85 (1924-1925).

Deutsche Entomologische Gesellschaft, E.V.—Deutsche Entomologische Zeitschrift, 1923, 4-5 (T.p. & c.) (1923); 1924, 1-6 (T.p. & c.) (1924); 1925, 2-3 (1925).

Deutsche Entomologische Museum.—Entomologische Mitteilungen, xiii, 6 (T.p. & c.) (1924); xiv, 1-6 (T.p. & c.) (1925); Supplementa Entomologica, No. 11 (1925).

Notgemeinschaft der Deutschen Wissenschaft.—"Flora", Neue Folge, xvii, 4 (T.p. & c.) (1924).

BERN.

Naturforschende Gesellschaft.—Mitteilungen a.d. Jahre, 1923, 1924 (1924, 1925); Verhandlungen, 1924 (1924).

BIELEFELD.

Naturwissenschaftlicher Verein für Bielefeld und Umgegend.—Die Jahre 1911, 1912 und 1913 (Dritter Bericht) (1914).

BIRMINGHAM.

Birmingham Natural History and Philosophical Society.—List of Members, 1925, and Annual Report, 1924 (1925); Proceedings, xv, 3-4, Sessions 1923-24 and 1924-25 (1925).

BOMBAY.

Bombay Bacteriological Laboratory.—Report for the Year 1923 (1924).

Bombay Natural History Society.—Journal: Title page and Index for xxix, 3 and 4 (1924); xxx, 1-3 (1924-1925).

BOSTON.

American Academy of Arts and Sciences.—Proceedings, lviii, 8 (1923); lix, 10-17 (T.p. & c.) (1924-1925).

BRISBANE.

Department of Agriculture and Stock.—Queensland Agricultural Journal, Title page and contents for xxi (1924); xxii, 5-6 (T.p. & c.) (1924); xxiii, 1-6 (1925); xxiv, 1-5 (1925).

Department of Mines, Queensland Geological Survey.—Publication 275 (1920).

"Queensland Government Mining Journal" (from the Editor).—xxv, Dec., 1924 (T.p. & c.) (1924); xxvi, Jan.-Oct., 1925 (1925).

Queensland Museum.—Memoirs, viii, 2 (1925).

Queensland Naturalists' Club and Nature-Lovers' League.—"The Queensland Naturalist", iv, 6 (1924); v, 1-2 (1925).

Royal Geographical Society of Australasia, Queensland Branch.—Queensland Geographical Journal, N.S. xxxix, 1923-1924 (1924); Transactions, i (1925).

Royal Society of Queensland.—Proceedings, xxxvi, 1924 (1925).

BROOKLYN.

Botanical Society of America.—American Journal of Botany, xi, 9 (1924); xii, 1-8 (1925).

BRUSSELS.

Académie Royale de Belgique.—Annuaire, 1923, 89th Année (1923); 1925, 91st Année (1925); Bulletin de la Classe des Sciences, 1922, 9-12 (T.p. & c.) (1922-1923); 1924, 4-12 (T.p. & c.) (1924-1925); 1925, 1-3 (1925).

Société Royale de Botanique de Belgique.—Bulletin, lvii, 1, 1924 (1925).

BUENOS AIRES.

Museo Nacional de Historia Natural.—Anales, xxxi-xxxii (1923-1925).

Sociedad Argentina de Ciencias Naturales.—Revista "Physis", vii, 25-26 (1924).

CAEN.

Société Linnéenne de Normandie.—Bulletin, 7th Ser. vi, 1923 (1924); Mémoires, xxvi, 1 (1924).

CALCUTTA.

Geological Survey of India.—Memoirs, T.p. & c. for xlv (1925); xlviii, 2 (T.p. & c.) (1924); Memoirs, Palaeontologia Indica, N.S. T.p. & c. for v

(1925); vi, 4 (T.p. & c.) (1925); viii, 2-3 (1924-1925); Records, lvi, 2-3 (1924-1925); lviii, 1 (1925).

Indian Museum.—Memoirs, v, 13 (1924); viii, 2-3 (1925); Records, xxiv, 2 (1922); xxvi, 5-6, Appendix (T.p. & c.) (1924-1925); xxvii, 1-4 (1925).

CAMBRIDGE, England.

Cambridge Philosophical Society.—Proceedings, Biological Sciences, i, 3-4 (T.p. & c.) (1924-1925); Transactions, xxiii, 4-7 (1924-1925).

CAMBRIDGE, Mass.

Museum of Comparative Zoology at Harvard College.—Annual Report of the Director for 1923-1924 (1924); Bulletin, lvii, 7 (1925); lxv, 13-14 (T.p. & c.) (1924); lxvi, 1-2 (1924-1925); lxvii, 1 (1925).

CAPE TOWN.

Royal Society of South Africa.—Transactions, xii, 1-4 (T.p. & c.) (1924-1925).

South African Museum.—Annual Report for the Year ended 31st December, 1924 (1925); Annals, T.p. & c. for viii (1911); xii, xiv (1924); xvi, 2 (1925); xix, 4 (T.p. & c.) (1925); xx, 3-4 (1924-1925); xxi, 1 (1925).

CHERBOURG.

Société Nationale des Sciences Naturelles et Mathématiques de Cherbourg.—Mémoires, xxxix (1913-1923).

CHICAGO.

Field Museum of Natural History.—Report Series, vi, 3 (1924).

CHRISTCHURCH.

Canterbury Museum.—Records, ii, 4 (1924).

Philosophical Institute of Canterbury.—Transactions and Proceedings of the New Zealand Institute, lv (1924).

CHRISTIANIA.

University of Christiania.—Archiv for Mathematik og Naturvidenskab, xxxviii, 1-4 (T.p. & c.) (1921-1923).

Videnskapsselskapet i Kristiania.—Fordhandlinger, Aar 1923, 1924 (1924); Skrifter, 1923, 1924 (2 vols.) (1924).

CINCINNATI.

Lloyd Library.—Mycological Notes, Nos. 66-72 (Vol. vii, 1-7) (1922-1924).

CLUJ, Roumania.

Gradina Botanica.—Bulletin, iv, 2-4, Appendix 1 (T.p. & c.) (1924); v, 1-2 (1925); Contributions Botaniques, i, 6-7 (1924-1925).

COLD SPRING HARBOR.

Station for Experimental Evolution, Carnegie Institution of Washington.—Annual Report of the Director of the Department of Genetics, 1923-1924 (Extracted from Year Book No. 23 for the Year 1924) (1924).

COLOMBO.

Colombo Museum.—"Manual of the Birds of Ceylon" by W. E. Wait (1925); Spolia Zeylanica, xii, 47-48 (1924); Spolia Zeylanica (Ceylon Journal of Science, Section B—Zoology and Geology), xiii, 1-2 (1924-1925).

COLUMBUS, Ohio.

American Chemical Society.—Industrial and Engineering Chemistry, xii, 8 (1920); xvi, 11-12 (T.p. & c.) (1924); xvii, 1-10 (1925); News Edition, ii, 20-24 (Index) (1924); iii, 1-18 (1925).

Ohio Academy of Science and Ohio State University Scientific Society.—Ohio Journal of Science, xxiv, 5-6 (T.p. & c.) (1924); xxv, 1-4 (1925); "The Ohio Naturalist", i, 1-5, 7-8 (1900-1901); ii, 1-8 and contents (1901-1902); iii, 1-8 (T.p. & Index to i-iii) (1902-1903); iv, 1-3 (1903-1904).

Ohio State University.—Bulletin, xxix, 5 (1924).

COPENHAGEN.

Det. Kgl. Danske Videnskabernes Selskab.—Biologiske Meddelelser, ii, 2-5 (T.p. & c.) (1920); iii, 1-10 (T.p. & c.) (1921-1922); iv, 1-4 (1923-1924); Oversigt, Juni, 1922-Maj, 1923; Juni, 1923-Maj, 1924 (1923-1924).

Zoological Museum of the University.—Publications, Nos. 32, 37-39 (1924-1925); The Danish Ingolf-Expedition, ii, 6-7 (1923-1924); iv, 5 (1923).

DUBLIN.

Royal Dublin Society.—Scientific Proceedings, N.S. xvii, 42-47 (T.p. & c.); xviii, 1-4 (1924).

Royal Irish Academy.—Proceedings, Section B, xxxvi, 12-16 (T.p. & c. for Section B and General) (1924); xxxvii, 1-8 (1924-1925).

EAST LANSING.

Michigan Agricultural College, Agricultural Experiment Station.—Quarterly Bulletin, vii, 3 (1925); Report of the Section of Bacteriology for 1922-23 (1923); Technical Bulletin Nos. 65, 66 (1924).

EASTON.

American Chemical Society, Section of Chemical Education.—Journal of Chemical Education, ii, 7 (July, 1925).

EDINBURGH.

Royal Society of Edinburgh.—Proceedings, xliv, 3 (T.p. & c.), Session 1923-24; xlv, 1-3, Session 1924-25 (1925); Transactions, liii, 3 (T.p. & c.), Session 1924-25 (1925).

FRANKFURT ON MAIN.

Senckenbergische Naturforschende Gesellschaft.—Abhandlungen, Index for xxxv; xxxviii, 3; xxxix, 1 (1925); Bericht, 54, 2-4 (T.p. & c.) (1924); 55, 1-10 (1925); Verzeichnis der Laufenden Ausländischen Zeitschriften (April, 1925).

GENEVA.

Société de Physique et d'Histoire Naturelle—Compte Rendu des Séances, xxxvi, 2 (1919); xli, 3 (T.p. & c.) (1924); xlii, 1 (1925); Mémoires, xxxix, 1 (1917).

GRAHAMSTOWN.

Albany Museum.—Records, iii, 4 (1925).

GRANVILLE.

Denison University.—Journal of the Scientific Laboratories, xx, pp. 187-383 (T.p. & c.) (1924).

HELSINGFORS.

Societas pro Fauna et Flora Fennica.—Acta lii, 1921-1923 (1923); Acta Botanica Fennica, i, 1 (1925); Meddelanden, 48-49, 1921/22-1922/23 (1925).

Societas Scientiarum Fennica.—Commentationes Biologicae, i, 7-9 (T.p. & c.) (1924); Commentationes Physico-Mathematicae, ii, 1-18 (1924).

Societas Zoolog.-botanica Fennica Vanamo.—Annales, i (1923).

HOBART.

Department of Mines, Geological Survey.—Geological Survey Bulletin Nos. 35-36 (1925); Mineral Resources No. 8, Vol. i (1924).

Royal Society of Tasmania.—Papers and Proceedings for the Year 1924 (1925).

Tasmanian Field Naturalists' Club.—Easter Camp, 1925 (1925); "The Tasmanian Naturalist," N.S. i, 2 (1925).

HONOLULU, T.H.

Pan-Pacific Union.—Bulletin, N.S. Nos. 63-70 (1925); Proceedings of the First Pan-Pacific Food Conservation Conference held at Honolulu, July 31st to Aug. 14th, 1924 (1925) (sent through the Premier's Department, Sydney).

ITHACA, N.Y.

Cornell University.—Thirty-three theses (1919-1924) and "The Baker Laboratory of Chemistry at Cornell University", by L. M. Dennis (1923).

JAMAICA PLAIN.

Arnold Arboretum.—Journal, v, 3-4 (T.p. & c.) (1924); vi, 1-3 (1925).

JOHANNESBURG.

South African Association for the Advancement of Science.—South African Journal of Science, xxi (1924).

KURASHIKI.

Ohara Institute for Agricultural Research.—Berichte, ii, 4 (1924).

LA JOLLA.

Scripps Institution for Biological Research of the University of California.—"Observations on Surface Distribution of Marine Diatoms, etc." by W. E. Allen ("Ecology", v, 4, pp. 389-392, 1924); "Surface Catches of Marine Diatoms, etc." by W. E. Allen (Univ. of California, Publication, Zoology, xxvi, 12, 1924).

LA PLATA.

Museo de La Plata.—Obras Completas y Correspondencia Cientifica de Florentino Ameghino, iv (1915).

LENINGRAD.

Académie des Sciences de Russie.—Bulletin, Serie vi, xviii, 1924, 1me Partie, Nos. 1-11 (Jan.-Juin, 1925).

LIÉGE.

Société Géologique de Belgique.—Annales, xlvii, 1-3 (1924-1925); xlviii, 1 (1925).

Société Royale des Sciences de Liége.—Mémoires, 3me Serie, xii (1924).

LIVERPOOL.

Liverpool School of Tropical Medicine.—Annals of Tropical Medicine and Parasitology, xviii, 3-4 (1924); xix, 1-3 (1925).

LONDON.

British Museum (Natural History).—A Catalogue of the Recent Sea-Urchins (Echinoidea) in the Collection of the British Museum (Natural History), by H. L. Clark (1925); Catalogue of the Type Specimens of Lepidoptera Rhopalocera in the British Museum. Part 1, Satyridae, and Part 2, Danaidae. By N. D. Riley and A. G. Gabriel (1924-1925); Fossil Insects, Nos. 1-2 (1925); Guide to the Fossil Plants in the Department of Geology and Palaeontology (1925); Index animalium, Second Section, Parts iv, v and vi, by C. D. Sherborn (1924-1925).

Entomological Society of London.—"Report of the British National Committee on Entomological Nomenclature" (1925); Transactions, 1922, 1-2 (1922); 1924, 3-5 (T.p. & c.) (1925); 1925, 1-2 (1925).

Geological Society.—Quarterly Journal, lxxx, 4 (T.p. & c.) (1924); lxxxi, 1-2 (1925).

Linnean Society.—Journal, Botany, xlvi, 311 (T.p. & c.) (1924); xlvii, 312 (1925); Zoology, xxxvi, 240-241 (1924-1925); List, 1924-1925 (1924); Proceedings, 136th Session, 1923-1924 (1924); Transactions, 2nd Series, Zoology, xviii, 2 (T.p. & c.) (1925).

Ministry of Agriculture and Fisheries.—Journal, xxxi, 8-12 (T.p. & c.) (1924-1925); xxxii, 1-7 (1925).

Royal Botanic Gardens, Kew.—Bulletin of Miscellaneous Information, 1924 (1925).

Royal Microscopical Society.—Journal, 1924, 4 (T.p. & c.) (1924); 1925, 1-2 (1925).

Royal Society.—Philosophical Transactions, Series B, ccxiii, Nos. B 405-410 (T.p. & c.); ccxiv, Nos. B 411-412 (1925); Proceedings, Series B, xcvii, Nos. B 680-686 (T.p. & c.) (1924-1925); xcviii, Nos. B 687-692 (1925).

Zoological Society.—Abstract of Proceedings, Nos. 256-267 (1924-1925); List of Fellows, April, 1925 (1925); Notices re Meetings, Jan. and Oct., 1925 (1925); Proceedings, 1924, 3-4 (T.p. & c. for pp. 697-1176) (1924); 1925, 1-2 (T.p. & c. for pp. 1-798) (1925).

MADRID.

Junta para Ampliacion de Estudios.—Flora Iberica. Uredales, ii (1925); Trabajos del Museo nacional de Ciencias Naturales, Serie Botanica, No. 19 (1925); Serie Zoologica, Nos. 49 and 50 (1924).

Real Sociedad Espanola de Historia Natural.—Boletin, xxiv, 7-10 (T.p. & c.) (1924); xxv, 1-5 (1925); Memorias, xi, 9 and Index (1924).

MANCHESTER.

Conchological Society of Great Britain and Ireland.—Journal of Conchology, xvii, 6-8 (1924-1925).

Manchester Literary and Philosophical Society.—Memoirs and Proceedings, lxviii, 1923-24 (1924).

Manchester Museum.—Museum Publications, 87, 88 (1924).

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LIST OF MEMBERS, 1925.

Ordinary Members.

1905 Allen, Edmund, c/o Chief Engineer for Railways, Brisbane, Q.
1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College Street, Sydney.
1922 Anderson, Robert Henry, B.Sc. (Agr.), Botanic Gardens, Sydney.
1899 Andrews, Ernest Clayton, B.A., F.G.S., Geological Survey, Department of Mines, Sydney.
1912 Aurousseau, Marcel, B.Sc., c/o Mr. G. H. Aurousseau, "Wondah", Bannerman Street, Cremorne.

1913 Badham, Charles, B.Sc., M.B., Bureau of Microbiology, 93 Macquarie Street, Sydney.
1888 Baker, Richard Thomas, The Avenue, Cheltenham.
1925 Barnard, Colin, "Brogo", Baillie Street, Huntley's Point, Sydney.
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